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ABSTRACT

Descriptions of 93 museum collections and exhibit centers in the United States and Canada are provided. Entries are grouped into four categories: (1) air and space, (2) natural history, (3) science and technology, and (4) special topics museums. Within each category the museums have in turn been broken down into major ones (which have lengthy descriptions) and "honorable mentions" (which have briefer descriptions). In some cases, the honorable mentions are smaller institutions with unique exhibits that will be unknown to many science buffs. Each entry includes the museum's name, address, and telephone, and information on hours, admission fees, publications, reproductions (such as posters, postcards, prints, slides, etc.), and research opportunities. Lists of museums by regions and by subject categories are included in appendices. In addition, the names of all museums described are listed in the table of contents. (JN)

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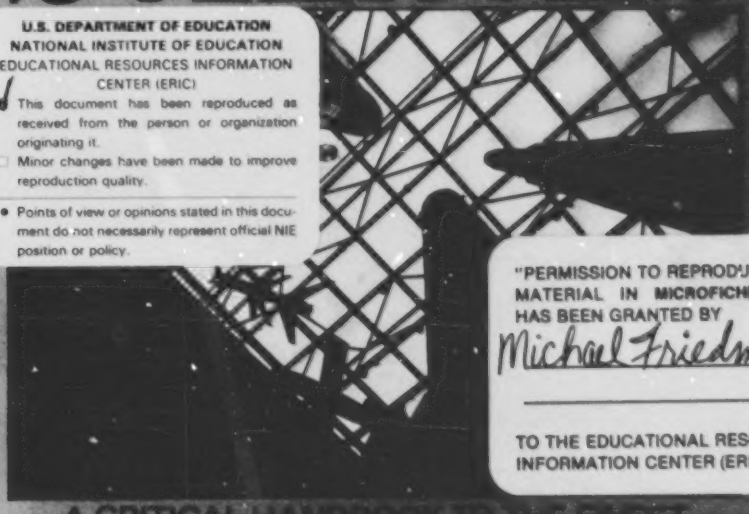

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A CRITICAL HANDBOOK TO THE FINEST COLLECTIONS IN THE UNITED STATES

• Air & Space • Natural History •
• Science & Technology • Special Topics •

Paul Hoffman, Consulting Editor

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AMERICAN MUSEUM GUIDES

SCIENCES

Paul Hoffman, Consultant Editor

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INTRODUCTION

by
PAUL HOFFMAN

Not long ago the cognoscenti dismissed science museums as the ugly ducklings of the museum world. Science museums specializing in natural history were regarded as musty halls jammed full of stuffed sparrows, mounted moose, embalmed elk and others of that ilk. Those that emphasized technology were written off as unwieldy collections of nuts and bolts. This attitude has changed, however, and so have the museums, as science has emerged as a dominant force in our culture.

Today, science museums do more than record the history and the progress of science. They also serve to elucidate scientific discoveries and theories that underlie some of the most contested and important issues of our day: the role of genes in human behavior, the significance of the so-called gaps in the evolutionary table, the nature and the extent of computer intelligence, the control of toxic wastes, the feasibility of alternative energy sources, the safety of nuclear reactors and the possibility of "futuristic" arms.

This century has seen two revolutions in physics and one in biology, and all three have been dramatically documented in science museums. In physics, relativity theory overturned our conception of massive matter, and quantum mechanics completely changed our picture of microscopic matter. In biology, investigations at the molecular level, traced the molecular basis of life to the structures of DNA and RNA.

With their multi-media, hands-on exhibits, museums can bring science to life in a way that neither books nor television can. The exhibit I remember most vividly is a display about probability in the "Mathematica" hall, designed by Charles and Ray Emmes, at the California Museum of Science and Industry and at the Museum of Science in Boston. I had always taken it on intuition or faith that in probability the normal distribution is a bell-shaped curve. But here,

to my delight, was a display that demonstrated this fact uncontrovertibly. Hundreds of ping pong balls are shot vertically into the air are allowed to fall into narrow, transparent tubes lined up vertically one after another. The most balls accumulate, of course, in the tube nearest the place the balls are launched from, and the fewest balls collect in the tubes that are farthest away. Sure enough, the mathematicians are right: the distribution of balls from tube to tube forms a bell-shaped curve.

Science museums often contain all sorts of surprising curiosities because there is no established way to set one up and because they receive their funding from many different sources that earmark the money for particular exhibits. In 1982 I spent two whole weeks in Chicago's titanic Museum of Science and Industry concocting 20 diabolical riddles about the exhibits for a promotional contest. I was startled—and fascinated—to find a large exhibit on fetal development in a museum known the world over for its innovative technology displays. A series of fetuses, arranged chronologically, shows the stages of prenatal development; for example, you can see, to the day, when the fetus grows finger nails.

THE AMERICAN MUSEUM GUIDES—SCIENCES covers 93 museum collections and exhibit centers in the United States and Canada. They have been divided into four categories: natural history, science and technology, air and space, and special topics museums. Within each category the museums have in turn been broken down into major ones, which have lengthy write-ups, and honorable mentions, which have briefer entries. In some cases the honorable mentions are smaller institutions with unique exhibits that will be unknown to many science buffs.

The authors of the sections are distinguished writers in the museum field. Douglas J. Preston, who wrote the natural history section, is the managing editor of *Curator*, a magazine about museums and their management. He also writes the "At the American Museum" column for *Natural History*. Victor J. Danilov, who is responsible for the science and technology section, is the President and Director of the Museum of Science and Industry in Chicago. His most recent book is *Science and Technology Centers*, published by the MIT Press. Mitchell R. Sharpe, the author of the air and space section, is historian emeritus of the Alabama Space and Rocket Center. He has written eight books, including one about the first female astronaut, *It is I Seagull, the Story of Valentina Tereschkova*. Pamela Rogow, who wrote the specialty section, has her own design firm that develops exhibits for museums and other institutions.

The museums in the natural history section have exhibits that

depict the history of the earth, the history of life itself and the rich diversity of flora, fauna and human beings that have inhabited this planet. Included in this section are famous museums, such as the American Museum of Natural History in New York, and lesser-known gems, such as the University of Nebraska State Museum, which includes a life-size reconstruction of the largest known mammal, baluchitherium, an ancestor of the rhino whose shoulder was 18 feet off the ground. The following are examples of the variety of exhibits found in natural history museums:

•a two-minute animated film that shows the geologic history of the earth from the time the planet condensed out of interstellar dust and gas until the present (the Arizona-Sonora Desert Museum).

•the tip of an iceberg that you can climb on (Planet Ocean).

•847 life-sized, completely realistic glass models of flowers and plants, and two 18-foot before-and-after shots of Mt. St. Helens (Harvard Museums).

•Rudolph Zallinger's 16-foot-by-100-foot Pulitzer Prize-winning mural that traces the evolution of dinosaurs (Yale Peabody Museum of Natural History).

•the world's largest recovered meteorite (weighing in at 34 tons), the world's smallest bee (a mere one thousandth of an ounce), a two-ton slab of jade, 596 pounds of topaz and a quarter of a million dollars worth of gold (American Museum of Natural History).

The museums in the science and technology section reflect the increasing importance of technology in our culture. The exhibits trace technological developments from the discovery of the wheel to the invention of the magnetic-bubble memory. The range of exhibits is remarkable and includes:

•"Dr. Know," a talking computer that offers psychological counseling (Oregon Museum of Science and Industry; Maryland Science Center).

•The world's largest (and working!) Van de Graaff generator and a 90-foot-long wave tank (Boston Museum of Science).

•120 computer terminals that you can use for games, simulations, music composition and speech generation (Lawrence Hall of Science).

•An exhibit that demonstrates the principles of vision that are the basis of three-dimensional movies (Oregon Museum of Science and Industry).

•Equipment that monitors the activity of a nearby volcano and a working model of tidal flow in Puget Sound (Pacific Science Center).

•Edison's first phonograph, the first American particle accelerator to split an atom and the original, 42-foot-by-30-foot Star Spangled Banner (National Museum of American History).

•Henry Ford's first car, the 1909 Sears Motor Buggy that was sold through the Sears Catalog for $325; a 10-person, 23-foot-long bike, and planes in which Admiral Byrd flew over the poles (Henry Ford Museum).

•Hands-on exhibits in which you can move a 500-pound block with the aid of pulleys and play the world's largest pinball machine (Franklin Institute Science Museum).

•A World War II German submarine, the first vessel the United States captured on the high seas since the War of 1812 (Museum of Science and Industry, Chicago).

The air and space section includes museums devoted to the history of aviation, the history of space exploration and research in astronomy, astrophysics and meteorology. Also included are planetariums. Like original works of art, the artifacts housed in these museums are one-of-a-kind. There's only one "Spirit of St. Louis" (in the National Air and Space Museum), one Apollo 17—the last craft to go to the moon (Johnson Space Center) and one Apollo 12 command module (Langley Research Visitor Center).

Air and space museums, however, are much more than repositories of planes and space-age relics. They also include exhibits on how aircraft and rockets work. The Roswell Museum, for example, has a replica of the workshop of Robert Goddard, who launched the first liquid-propellant rocket; next to the workshop are displays illustrating the mechanism of rocket engines and liquid-propellant pumps. Other museums give you a feel for what traveling in space is like. At the Kansas Cosmosphere & Discovery Center you can even try on a space helmet, if you're in the mood.

The museums and exhibit centers in the special topics section are unique institutions, many of which deal with unexpected subjects. The Corning Museum of Glass, which is devoted to—you guessed it—the history of glass making, contains a long, conical drinking glass that was used by Frankish barbarians; the glass has no base because true barbarians kept drinking and drinking. The Computer Museum, whose walls are covered by giant, computer-generated murals, has the world's first video game as well as other more meaningful relics of the computer age. The Museum of Holography has 1,500 holograms—three-dimensional images that look like they're really there—and exhibits on how they're constructed. The National Collection of Medical Quackery houses the $500 Sonus Film-O-Sonic, which cures cancer by playing "Smoke Gets in Your Eyes." The Fermi National Accelerator Center, where much of the U.S.'s research on high-energy particle physics is done, has exhibits that show how particle physicists search for the ultimate constituents of matter.

CHAPTER ONE

AIR & SPACE

by
MITCHELL R. SHARPE

AIR FORCE SPACE MUSEUM

EASTERN SPACE AND MISSILE CENTER, PATRICK AFB, FL 32925.
Tel: (305) 494-7631.
Hours: Sun 9 am–3 pm.
Admission: Free.
Publications: Free brochure.
Reproductions: None.
Research: None.

The Air Force Space Museum and Eastern Test Range—from which men and spacecraft have long been launched—offers visitors a rare opportunity to relive U.S. space history from Explorer I to the Space Shuttle. The museum is at the site of historic launch complex 26 at Cape Canaveral Air Force Station, FL, where astronauts Alan Shepard and Virgil I. Grissom first lifted into suborbital space aboard the Mercury spacecraft. The pad was also the site of other historic launchings including the flights of primates Ham, Gordo, Able and Baker; Jupiter-C; and Juno flights.

Called the "Kitty Hawk of the Space Age," the museum displays missiles, rockets and related space equipment including artifacts of past and present developments in the space program and offers audio-visual exhibits.

The U.S. Air Force Space Museum has hundreds of artifacts and displays donated by the U.S. Air Force, the National Aeronautics and Space Administration, U.S. Department of Defense, contractors and individuals.

Indoor exhibits illustrate the history and development of rockets and launch systems, the U.S. Air Force role in support of manned and unmanned space exploration projects and the mission of the Eastern Test Range itself, which stretches from the Florida Coast to the Indian Ocean.

Electronic equipment in blockhouse control rooms where engineers and scientists first observed launchings has been authentically restored.

The Museum, located on 40 acres at the birthplace of America's manned and unmanned space quests, displays rockets ranging from the German V-I buzz bomb, Mercury Redstone and Atlas and Titan ICBMs to other mammoth military and scientific boosters.

Missiles include the Rascal, left, and Mace, right. Background: A Delta space vehicle is launched.

Drive-through tours of Cape Canaveral Air Force Station are available for a first-hand look at ICBM row and launch pads, which depict the extent of the technical challenges overcome by space and rocket pioneers. (The tours cover 20 miles.) Checkpoints guide visitors from one location to the next. Several hours are needed for the tour.

Along the route is an Air Force Minuteman missile complex and launch sites for Atlas Centaurs that took Pioneer 10 and 11 on a trip to the vicinity of Jupiter, Saturn and Uranus. Launch complex 12 and 13 tell the story of the Mariner spacecraft that flew past Venus and Mars. Complex 14 is also on the tour. It was from this site that the Earth-orbiting Mercury astronauts were launched in the 1960's. Complex 15 was the first of a series of Titan II ICBM complexes, and Complex 16 is used as a test launch site for U.S. Army Pershing missiles.

Complex 17 is still an active pad from which are launched the Delta rockets that orbit a variety of scientific satellites as well as communications, weather, and navigational satellites such as Marisat, Intelsat, Westar and Meteosat.

Complex 19 was used for the two-man, Earth-orbital Gemini spacecraft, while complexes 34 and 37 were built for the space agency's Saturn I and IB launch vehicles.

A Titan III launch complex, currently used for launching military satellites, can also be seen. The Titan III vehicle was used to launch the twin 1975 Viking missions to Mars and two Voyager missions to the vicinity of Jupiter and Saturn in 1977.

ALABAMA SPACE AND ROCKET CENTER

TRANQUILITY BASE, HUNTSVILLE, AL 35807. Tel: (205) 837-3400.
Hours: Sun–Sat 9 am–6 pm, closed Christmas.
Admission: $4 adults, $2.25 senior citizens and children.
Publications: None.
Reproductions: Posters and postcards of the base and related subjects.
Research: Teachers' resource center open to educators.

The Alabama Space and Rocket Center is the world's largest space museum. Its 400 acres are adjacent to the National Aeronautics and Space Administration's Marshall Space Flight Center and the U.S. Army Missile Command. Both organizations played leading roles in developing America's space program in the late 1950's.

The Alabama Space and Rocket Center is supported by both these agencies. It is the official visitors' information center for both the Marshall Center and the U.S. Army Missile Command. Opened in 1970, its establishment was largely due to the efforts of the late Wernher von Braun, former director of the Marshall Center and its antecedent in the US Army Missile Command.

Unlike most museums, the Center was designed with the philosophy of "hands-on" displays and exhibits.

The major features and activities of the Alabama Space and Rocket Center include a bus tour of the Marshall Center, the museum, a rocket and space vehicle park, several outdoor simulators and the Spacedome theater. Special group tours can also be arranged upon request.

The bus tour takes approximately two hours and is conducted by a guide. Among the historic places visited on the tour are a group of rocket test stands in which a number of early missile and space rocket engines were statically fired during their development. Such engines include the A-7 of the Redstone ballistic missile and the Juno 1 space launch vehicle, the H-1 and RL-10 engines of the Saturn 1B manned space launcher, and the F-1 and J-2 liquid propellant engines of the Saturn 5 rocket that sent the Apollo astronauts to the Moon. The Redstone test stand and its control bunker are designated National Historical Monuments.

One of the most interesting stops on the bus tour is at the Marshall Center's Neutral Buoyancy Simulator, the first such facility in NASA. It is a cylindrical tank 40 feet tall and 75 feet in diameter, holding 1,400,000 gallons of water. In it, spacesuited astronauts and technicians, deep underwater in simulated weightlessness, develop the techniques for moving in space to retrieve and repair satellites and to construct the multimanned space stations of the future.

At another stop, visitors on the tour view the Skylab and Spacelab. The former looks to the past and the latter looks to the present and future. They also see the huge external propellant tank of the Space Shuttle.

Skylab, America's first manned space station, was launched in 1973. Visitors walk through the Skylab and see the compartments in which astronauts lived and worked. They see the tools, living quarters, food, and scientific and engineering experiments of the astronauts as well as the

attached solar telescope, which the astronauts manned and maintained during the mission. They learn of the near failure of the space station and how the astronauts managed to repair it, utilizing techniques learned earlier in the Neutral Buoyancy Simulator.

Visitors also see the Spacelab. It was developed in Europe to be carried inside the cargo bay of the Space Shuttle orbiter. In Spacelab, various experiments in the many fields of space science and engineering are made by scientist-astronauts of Europe and America. Spacelab, like Space Shuttle, is designed to be reused.

Upon entering the Alabama Space and Rocket Center itself, visitors find themselves in a lobby featuring the Wernher von Braun room and a Moon rock returned by Apollo astronauts.

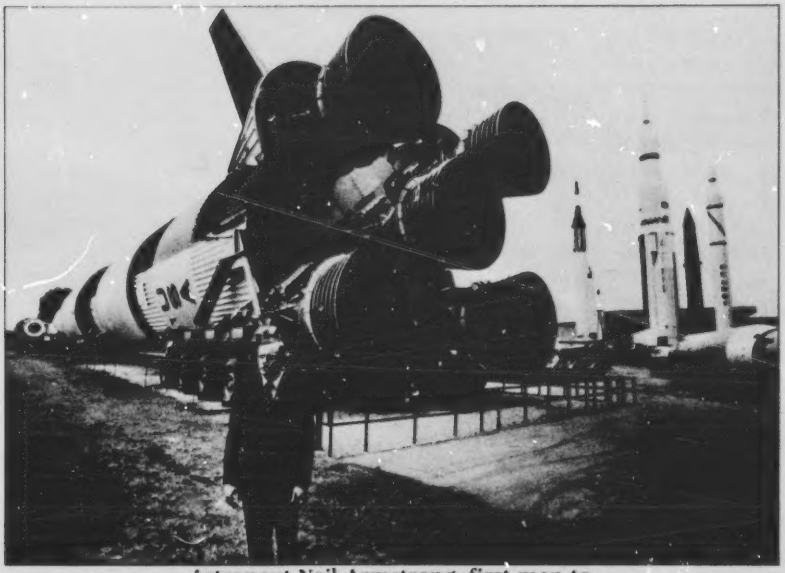
The Wernher von Braun Room contains 47 years of memorabilia of the rocket scientist who brought his team of fellow scientists and engineers to the United States at the end of World War II, moving them from Texas to Huntsville in 1950. Visitors see hundreds of photographs depicting his career in rocketry in both Germany and America, his many academic and professional awards and medals, the spacesuit he wore in making "dives" in the Marshall Center's Neutral Buoyancy Simulator, and the original manuscript of an essay he wrote in 1927, when he was 15 years old, titled "Space Mirror." Also displayed are copies of his Ph.D. dissertation on liquid propellant rocket propulsion. Of especial interest in the room is the correspondence between von Braun and Dr. Albert Schweitzer.

The atrium is the focus of static and dynamic displays and periodic presentations that demonstrate varied aspects of space science and technology. It is dominated by a full-scale replica of the Apollo Lunar Landing Module with a Lunar Rover and Apollo Lunar Scientific Experiment Package surrounding it. Suspended from the ceiling is a variety of scientific and "working" satellites, the descriptions of which are revealed to visitors as they view them through collimating tubes on a mezzanine overlooking the atrium. Typical satellites and probes include the Syncom, ATS, Mariner, Nimbus, Pegasus, Vostok and Surveyor. Also displayed are the Snap 10 nuclear engine test satellite and the Lunar Orbiter, which photographed the Moon in preparation for Apollo landings.

Dangling from the ceiling, in simulated flight, is the Quick airplane. This plane was built by Will Quick, a citizen of Madison County (in which Huntsville is located), and flown by him only a few years after the first flight of the Wright brothers at Kitty Hawk, NC.

Beneath these exhibits is the isolation trailer in which astronauts of Apollo 11 and 12 were quarantined after returning to Earth from the Moon. Nearby is a typical space station with astronaut models and equipment, arranged to suggest they are in zero gravity. Adjacent to this hypothetical space station are displays of experiments developed for use aboard Skylab.

Also in this area are two historic spacecraft: the Apollo 16, which went to the Moon in 1972 and the Mercury 7, which orbited Earth in 1962. Close-by are astronaut couches from the Space Shuttle, Gemini and Mercury spacecraft in which visitors can sit.



Astronaut Neil Armstrong, first man to walk on the Moon, stands in front of the Saturn 5 rocket that boosted him there.

Other items of interest include a full-scale model of the space telescope, to be placed in orbit by Space Shuttle. Visitors enter it and see a film that depicts the mission of the telescope and its experiments. A Lunar Landing Module simulator, used by the Apollo astronauts, is also displayed. The interior is an exact duplicate of the flight spacecraft. Another simulator utilized in the Apollo program is suspended from the ceiling near the Lunar Landing Module simulator. However, it is of quite a different type. The Lunar Landing Training Vehicle, dubbed "the flying bedstead" by the astronauts, was designed to simulate the behavior of the Lunar Landing Module in the one-sixth gravity of the Moon while flying over Earth.

Also in the atrium is the largest surviving piece of the Skylab space station to reach Earth after it reentered Earth's atmosphere. The charred remnants of an oxygen tank are exhibited with an eyewitness sketch of its reentry over Australia.

From a stage in the atrium, demonstrations are given of various aspects of work in space and space technology. They include operation of the space-suit and its life-support back-pack, walking in one-sixth gravity and working in weightlessness. Another demonstration illustrates the heat insulation properties of the Space Shuttle's tiles.

Elsewhere, visitors become acquainted with some of the basic physical principles involved in space flight, by means of hands-on devices. Particularly popular with children is the firing of a real liquid-propellant rocket

engine. Visitors activate the system and go through a countdown before pressing the ignition button, firing the engine. Other exhibits include a gyroscopic chair, which vividly demonstrates to visitors as they sit in it how the properties of the gyroscope are used to control and guide spacecraft. A vacuum jar enclosing a rocket engine and a propeller engine clearly shows why only a rocket engine will work in space. Best of all, perhaps, is the video computer simulator which allows visitors to try their hands at docking the Apollo spacecraft with the Soviet Soyuz spacecraft on a TV screen.

Also of particular interest are three exhibits that show laser images and holograms. Two of these are static displays showing images in color, but a third allows visitors to operate a laser target designator, demonstrating how the military has put the laser to practical use.

For the teacher, as well as the student, is a model of the Solar System. Standing in the simulated blackness of outer space, visitors look down upon the Sun with its planets and their satellites all orbiting at relative speeds. Another walk-through exhibit spans the journey from the Space Shuttle launch pad through its various current and future missions, including operation with large, multimanned space stations.

The historical aspects of astronautics and rocketry are featured on a mezzanine on one side of the atrium. A replica of the world's first successfully launched liquid propellant rockets, made by Dr. Robert H. Goddard in 1926 is on display. Nearby is the console from the blockhouse at Kennedy Space Center from which Explorer 1, America's first satellite, was launched. Surrounding it are artifacts of later space programs. A collection of spacesuits traces their development from early experimental models to the most recent. Associated with them are undergarments, space food and items used in recovering the Apollo astronauts after their landing at sea.

Outside the main building of the Alabama Space and Rocket Center is the rocket and missile park. It is one of the largest collections of guided missiles and space launch vehicles in the United States.

Clearly the most impressive of these is the 363-foot tall Saturn 5 that sent the Apollo astronauts to the Moon and launched the Skylab space station. On view next to it is a replica of the Skylab in full size. Other space vehicles include the Saturn 1, which launched the Pegasus satellite; the Mercury Redstone, which launched the first American astronaut into suborbital space; the Juno 1, which launched the Explorer 1, America's first satellite; and the Juno 2, that launched early American space probes.

Military missiles and rockets include one of the few German V-2 ballistic missiles of World War II still in existence, Titan 2, Minuteman, and Atlas intercontinental ballistic missiles, and the Redstone and Jupiter missiles, developed at the US Army Missile Command in the 1950's. Also shown is a rare Loon, the American version of the German V-1 rocket of World War II.

The rocket and missile park has three space simulators that are very popular, particularly with children. Lunar Odyssey is a centrifuge in which visitors strapped into space couches revolve at a speed producing the same acceleration that the crews of the Space Shuttle experience at lift-off. Star fields and other astronautical images are projected on the overhead screen

during the simulated space voyage. To experience the one-sixth gravity of the Moon, visitors sit in seats on the end of long arms pivoted to a base. By pushing upward, they travel through the arc at the top of which they feel one-sixth of their Earth weight. Sometime in the future, flights in the Space Shuttle will be experienced by the general public. The Shuttle Spaceliner simulator permits visitors to preview such flights. Inside a cabin that could be carried in a cargo bay on the Space Shuttle Orbiter, they experience a lift-off and journey through space.

The latest and most impressive addition to the Alabama Space and Rocket Center is its Spacedome. Within it is an Omnimax theater, one of only 10 in the world and the only one in the southeastern United States. Special 70-mm films are projected onto a hemispherical, overhead screen to an audience of 280 in inclined seats. The 6-track stereophonic sound system with 48 high-power speakers is so true that astronaut Ken Mattingly has said, of the film *Hail Columbia*, "The film is the closest to being on the Shuttle without actually being aboard." Shown alternately with *Hail Columbia* is the award-winning film *To Fly*, which depicts America as seen from hot-air balloon, biplane, jet aircraft and hang glider.

Additionally, the center has an extensive collection of original paintings by the renowned space artist Chesney Bonestell.

Undoubtedly one of the most popular programs of the Alabama Space and Rocket Center is its annual Space Camp for boys and girls between 12 and 14 years of age. For five days, the youngsters are involved in learning about every aspect of space technology. Each day's activities are explained in a session with a learn-as-you-go computer. Topics include the history and future of rocketry, manned space flight and living and working in space, experiences in gravity and weightlessness, and a simulated Space Shuttle mission with campers assuming the roles of astronaut crews and mission controllers. Much use is made of the simulators, field trips, computers, and the latest NASA audio-visual material in all phases of instruction.

Campers, from around the world, are at all times under the supervision of experienced counselors and are provided room and board in a special dormitory. Fourteen five-day camps are scheduled annually between June and September.

Visitors to the Alabama Space and Rocket Center can dine in the Lunch Pad cafeteria or on its ample picnic grounds. Its large parking area also has electricity and water hookups for self-contained recreational vehicles and motor homes. Kennels for pets, baby strollers, and wheelchairs are available at no charge. A large souvenir shop features books, plastic models, clothing, jewelry and other mementos of the center as well as rocketry and space flight in general. Cameras are permitted and encouraged both on bus tours and in the center.

AMERICAN MUSEUM OF NATURAL HISTORY, HAYDEN PLANETARIUM

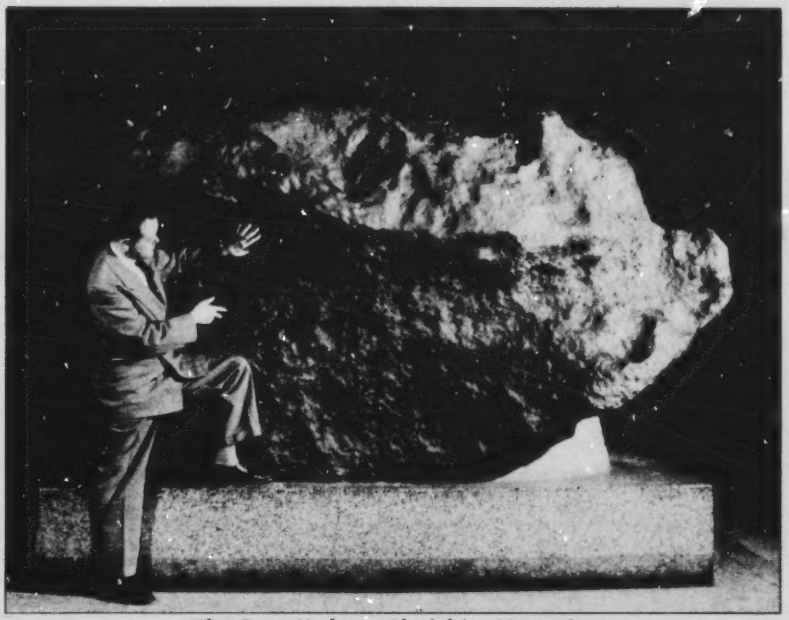
CENTRAL PARK WEST AT 81ST STREET, NEW YORK, NY 10024.
Tel: (212) 873-1300, extension 511.

Hours: Shows Mon–Fri 1:30 pm and 3:30 pm, Sat 2 pm, 3 pm, 4 pm, Sun 1–5 pm hourly. Check for specific shows.
Admission: $3.25 adults, $2.25 students and senior citizens, $1.50 children 2–12.
Publications: None.
Reproductions: None.
Research: Large astronomical library open by appointment to interested persons.

The first and only major museum exhibit in the world entirely devoted to the Sun is the major attraction of the American Museum-Hayden Planetarium located in New York City. Opened in 1935, the facility is north of the American Museum of Natural History at Margaret Mead Park.

The "Hall of the Sun," the planetarium's second floor attraction, is divided into three sections: the first illustrating how local stars affect planet Earth in climate, weather, crops, eclipses, rainbows, sunsets, time and energy. Many of the exhibits provide visitors an opportunity to push buttons, turn cranks, lift levers, and, in general, take part in them.

The second section highlights the Sun as a star in the universe. An eight-foot globe of the Sun as well as a scale model of the Earth, an inch in diameter, are shown for comparison. A 66-foot laser beam encased in lucite flashes between the Earth and Sun models, marking off the distance.



The Cape York, or Ahnighito Meteorite, with Joseph Chamberlain. It is the largest in the world, weighing 34 tons.

A mini-theater is the final section of the "Hall of the Sun" where visitors are treated to a short film of the best photographs ever made of the Sun, both from Earth and from space, accompanied by original music. The "Hall of the Sun" was designed by Chermayeff and Geismar Associates through a grant from the Billy Rose Foundation.

Also featured is an eclectic display of astronomical fact, history, and fancy called "Astronomia." This is sponsored and maintained by the IBM Corporation.

A focal point of the Hayden Planetarium is the world-famous Sky Theater, featuring the Zeiss Model VI planetarium projector with seating for 660 viewers. The projector, located under the Planetarium dome, is one of the largest of its kind in the world. The theater is used for special classes in astronomy and celestial navigation as well as for the daily sky shows and school presentations.

Educational components of the planetarium include courses in basic and advanced astronomy, electronic and celestial navigation, piloting, meteorology, aviation and science fiction. Three times during the year, in the evenings and on Saturday mornings, adult and young people can enroll in a course of interest. There is a fee for courses.

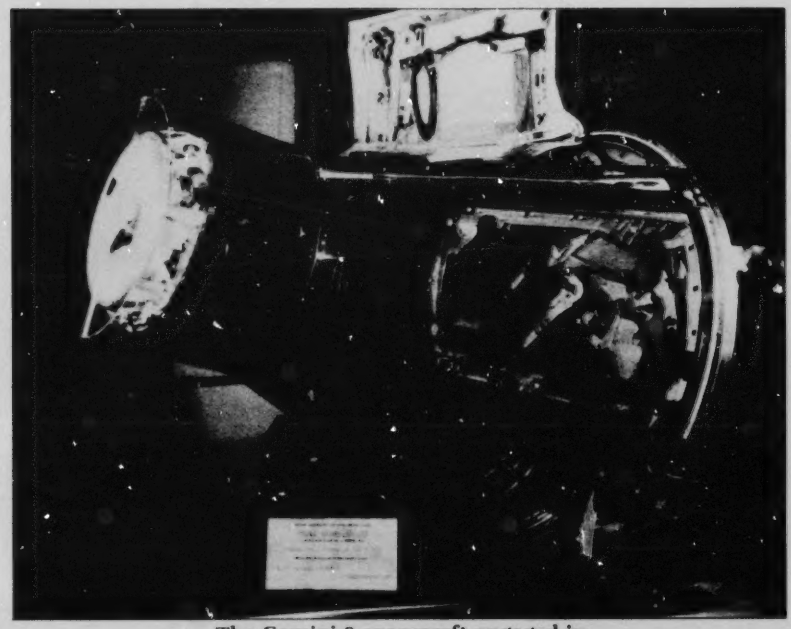
On the first floor of the planetarium is the Guggenheim Space Theater—a circular area with 22 screens for projecting a wrap-around slide presentation. This area is used primarily as an introduction to the sky show and includes one of the largest extant moving models of the solar system.

The 14-ton "Willamette" meteorite is also located on the first floor along with two gift shops, a blacklight gallery with large murals of astronomical subjects.

THE NEIL ARMSTRONG AIR AND SPACE MUSEUM

INTERSTATE HIGHWAY 75, WAPAKONETA, OH 45895.
Tel: (419) 738-8811.
Hours: Mon–Sat 9:30 am–5 pm, Sun 12–5 pm, closed December-February.
Admission: $2 adults, $1 children 6–12 and Ohio senior citizens.
Publications: None.
Reproductions: Postcards, posters, prints of the museum and related subjects.
Research: None.

One of the best regional aerospace museums of the U.S. is the Neil Armstrong Air and Space Museum. It is designed around the career of the first man to walk upon the Moon and the history of aviation and space in Ohio generally. (Indeed, the displays even include model airplanes that Armstrong built as a child!) The museum opened on July 20, 1972, on the third anniversary of Neil Armstrong's famous "moon walk." The architecture of the museum is in some ways reminiscent of the landscape which he saw upon stepping off the spacecraft Eagle. It is dominated by a 60-foot-diameter dome around which the museum itself is built. The dome encloses the astrotheater. Surrounding it are multi-level exhibits supporting the theme of Ohio's and America's contributions to aviation and space.



The Gemini 8 spacecraft engaged in the first U.S. space docking mission. It was commanded by astronaut Neil Armstrong.

The museum features three historic craft which Armstrong piloted in his career in aeronautics and astronautics. The earliest of these is the 1946 Aeronca 7AC Champion light plane in which he learned to fly when he was 16 years old. Also on display is the F5D Skylancer jet plane which is one of several aircraft Armstrong flew as a test pilot in the early 1960's for the National Aeronautics and Space Administration at Edwards Air Force Base, California, now the Dryden Test Flight Center. Also featured is the Gemini 8 two-man spacecraft in which Armstrong and fellow astronaut David Scott orbited the Earth on March 16, 1966. The suspenseful story of this near-tragic space mission is recounted for visitors in a video tape recording above the spacecraft. Associated with the Gemini 8 is the spacesuit that Armstrong wore on that historical mission.

Despite the emphasis on Armstrong and space, the museum has a wider scope in the history of science and technology. Of interest to the visitor from Ohio and the Middle West and the student of manned flight in the atmosphere are two very important exhibits in aeronautics. These are the Toledo 2 airship and the Model G flying boat of the Wright brothers. The former was built in 1905 by A. Roy Knabenshue, a native of Ohio. The latter was a product of the famous Wright brothers and was built in Dayton in 1913. Also on display is a wicker gondola, equipment, and other memorabi-

lia of Warren Rasor, an early Ohio aeronaut of Dayton. These displays not only illustrate the role played by Ohio in the advancement of aeronautics and astronautics, but expand the museum's scope to include the earliest experiments in man's heavier-than-air flying machines.

The story of American spaceflight from the Mercury project of the 1960's to the Space Shuttle of the 1980's is continuously presented to visitors on specially prepared videotape programs and NASA space films in the astrotheater, the entrance to which is mirrored in such a way as to reflect the image of the visitor projected to infinity.

CALIFORNIA MUSEUM OF SCIENCE AND INDUSTRY

700 STATE DRIVE, EXPOSITION PARK, LOS ANGELES, CA 90037. Tel: (213) 744-7400.
Hours: Daily 10 am–5 pm, closed Thanksgiving, Christmas and New Year's.
Admission: Free.
Publications: None.
Reproductions: None.
Research: None.

Spacecraft and air vehicles hang in suspension from the ceiling of the California Museum of Science and Industry, telling the story of the dawn of the Space Age. Located in Exposition Park in Los Angeles, the museum is the oldest of its kind in the Western United States with plans for major expansion of its aerospace exhibits. The 12,000-square-foot facility chronicles aviation from Da Vinci's "ornithopter" flying machine to the latest communication satellites, mockups, and actual space hardware.

Models of rockets, including the Saturn V, and exhibits explaining unmanned space missions are included, along with displays on lunar expeditions, the Apollo-Soyuz joint US/USSR space mission and the Space Shuttle. Special events such as Space Week and space symposia are periodically scheduled. The museum also has one of the few IMAX, large-screen theaters in the country for showing special space films.

Expansion plans after the 1984 Olympics in Los Angeles involve adding 40,000 square feet for aerospace exhibits, displays on science fiction concepts which became fact, use of computers in data collection, space technology transfer, and telecommunications.

CHAMPLIN FIGHTER MUSEUM

4636 FALCON CIRCLE DRIVE, MESA, AZ 85205. Tel: (602) 830-4540.
Hours: Daily, 10 am–5 pm.
Admission: $4 adults, $2 children 4–14, free to children under 4.
Publications: Newsletter and small brochure.
Reproductions: Posters, prints and models of airplanes in the museum.
Research: Library for staff use.

The exploits of the famed "Red Baron" bring back memories at the Champlin Fighter Museum in Mesa, AZ, the world's most complete collection of World War I and World War II single-engine fighter aircraft. The museum is the

The Albatross D-V is a German plane from W.W.I. It is decorated with a dragon breathing fire and iron crosses.

creation of Oklahoma businessman Doug Champlin, who began this unique collection of historic combat aircraft in 1969.

Visitors relive the golden years of fighter aircraft development from 1914 to 1945 with planes representing some of the most advanced designs of their times. Most of the aircraft are in flyable condition, still others are being restored and added to the collection. All are painted and decorated in authentic patterns of the period.

In addition, more than 500 personally autographed photos of top fighter aces of 15 nations from World War I through the Vietnam War are on display along with 50 specially commissioned paintings of World War II aircraft in combat.

Among the historic aircraft of World War I are the Fokker Dr-I Triplane, flown in 1917 by German Ace, Manfred von Richthofen, known as the Red Baron. Also on display are the Fokker D-VII and D-VIII, Sopwith Pup, Sopwith Camel, Thomas-Morse S.4C, The Austrian Aviatik D-1, Albatross DVa, Pfalz DX-II and the Nieuport 27, all of which played significant roles in World War I of the immediate post-war years.

World War II aircraft on display include the Vought F4U-1d Corsair flown by Pappy Boyington's well-known "Black Sheep" squadron in the Pacific; the Curtiss P-40 Warhawk, Grumman FM-2 Wildcat and F6F-3 Hellcat Goodyear

F2G-1 Corsair, North American P-51 Mustang, Grumman F8F Bearcat, Republic P-47D Thunderbolt and the British Supermarine Spitfire Mk.IX. The German air force of World War II is represented by a Messerschmitt Me-109 and Focke Wulf FW-109.

Part of the museum itself is a bit of aviation history. The two hangars displaying aircraft once housed trainers used by British student pilots learning to fly in the U.S. during World War II.

HENRY FORD MUSEUM AND GREENFIELD VILLAGE

20900 OAKWOOD BOULEVARD, PO BOX 1970,
DEARBORN, MI 48121. Tel: (313) 271-1976.

Hours: Sun–Sat 9 am–5 pm.

Admission: Separate admission to museum and village: $8 adult, $7 senior citizen, $4 children 6–12, free to children under 6 and members.

Publications: Books and brochures include:

Geoffrey C. Upward, *A Home for our Heritage: The Building and Growth of Greenfield Village and Henry Ford Museum*. 1979, $9.95.

Fannia Weingartner, *Henry Ford Museum and Greenfield Village: A Pictorial Souvenir*. 1983, $3.95.

Reproductions: Posters, prints and postcards of the museum and village.

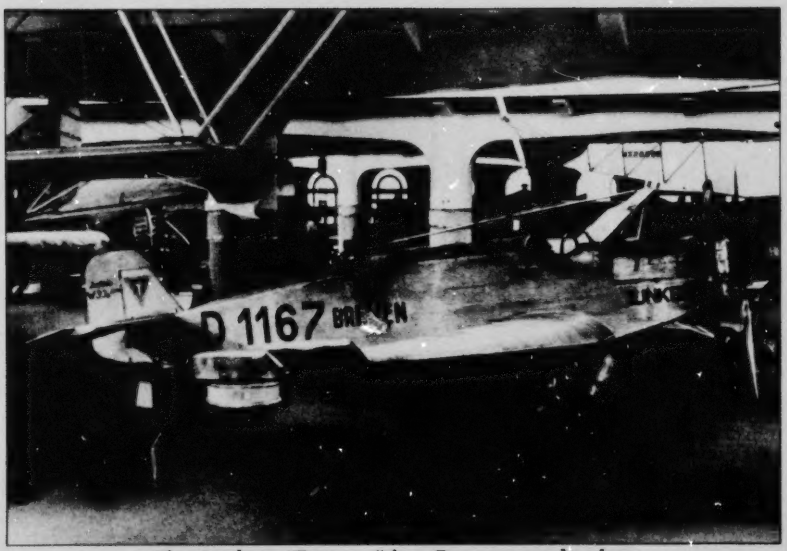
Research: Archive and research library open to qualified researchers by appointment.

While aerospace exhibits occupy only a small portion of the Henry Ford Museum, its collection is still one of the most significant in the Midwest. Located in Dearborn within walking distance of the place where the Ford Company once manufactured its reknowned Ford Trimotor airplane, the 14-acre museum is also adjacent to Dearborn Village, in which one can find the original bicycle shop and home of the Wright brothers, transplanted to the village from Dayton, OH.

The shop contains many of the tools used by Orville and Wilbur Wright in designing, building, and testing their first aircraft. Of particular interest is a wind tunnel they built for the purpose of designing wing airfoils with maximum lift.

The Museum has more than two dozen aircraft that participated in the advancement of aviation, especially of commercial flight. The oldest craft on display is a 1909 Bleriot XI, of the type which made the first flight across the English channel. Not far from it is the 1916 Laird biplane, manufactured by E.M. Laird, who toured China and Japan with it in 1917. This was the first airplane to make the acrobatic inside loop in mid-air. Another plane dating from 1917 is a Curtiss JN-4 "Jenny," favored by the barnstormers of the years following World War I. Two other planes of that era are a 1916 Standard J-1 and a 1916 Curtiss "Seagull" flying boat, the latter an elegant specimen made of mahogany and plywood.

Exploration of the Earth's polar regions is represented by two aircraft from the mid-1920s. They are the 1926 Fokker F VII "Josephine Ford," used by Admiral Richard Byrd to fly over the North Pole in 1926; and the 1928



The Junkers "Bremen" is a German-made plane from between the world wars. It exemplifies some of the most advanced aerodynamic technology of its day.

Ford Trimotor "Floyd Bennett," which Bennett himself piloted in flying Byrd over the South Pole for the first time in 1926. From the same period is the 1928 Junkers "Bremen," which was the first plane to make a westward crossing of the Atlantic Ocean in 1928.

With the success of his Model-T automobile on the nation's roads, it occurred to Henry Ford that private aviation could well use a "Model-T of the Air." Thus was conceived the 1928 Ford "Flivver." With a wingspan of less than 23 feet, the small plane could cruise at a speed of 100 miles per hour with thrust from a 40 horsepower engine made of magnesium. Only three were built, and in one of them Ford's test pilot was killed. Following the crash, Ford ceased production of the "Flivver" and shortly afterward got out of the commercial aircraft business altogether. A more successful early commercial plane is on view, however. It is a 1927 Boeing 40 B-2, used by United Airlines to carry mail and passengers on transcontinental routes, beginning in that year.

Although the original Ryan "Spirit of St. Louis," in which Charles Lindbergh flew the Atlantic Ocean, in 1927, is on display at the National Air & Space Museum, the Henry Ford has an exact duplicate. It was constructed in 1957 for use in making the film *The Spirit of St. Louis*.

The museum also exhibits two early rotary wing aircraft. The 1931 Pitcairn-Cierva PCA-2 autogiro was used by a Detroit newspaper for several years as a camera plane. The other craft is a Vought-Sikorsky VS-300; it was the first practical helicopter and was initially flown by Sikorsky in 1939.

Additional airplanes of note include a 1920 Baumann racing plane—the first to have a retractible landing gear, and two 1927 Stinson "Detroiter" planes, one of which made the world's first flight using a diesel engine in 1928.

The history and development of early aircraft engines is illustrated in a display of such early powerplants as a 1910 Elbridge, 1916 Clerget, 1917 Liberty V-12, 1916 Hispano-Suiza and several of Ford's own experimental aircraft engines.

The flavor of the early years of American aviation is further enhanced by displays of artifacts like goggles, helmets, trophies, propellers and cylinder castings. Associated with the museum is the Robert Tannahill Memorial Library, with more than 250,000 items.

THE FRANKLIN INSTITUTE

20TH STREET AND BENJAMIN FRANKLIN PARKWAY,
PHILADELPHIA, PA 19103. Tel: (215) 448-1200.

Hours: 10 am–5 pm daily, Sun 12–5 pm.
Admission: $3.50 adults, $3 students 12–college, $2.50 children 4–11, $2 senior citizens, free to children under 4.
Publications: None.
Reproductions: Postcards of the institute and related subjects.
Research: Library open free to members and staff; $2.50 per day to others by appointment. It is strong in the organic and physical sciences.

Orville and Wilbur Wright are well remembered at Franklin Institute, one of the nation's oldest museums, in Philadelphia. Founded in 1824, The Franklin Institute contains over 500 different exhibits, including the complete engineering notebooks, sketches and plans for the Wright brothers' first airplane. Orville Wright, long a member of The Franklin Institute, donated the works before his death.

The museum's Hall of Aviation is filled with "hands-on" exhibits, giving visitors an opportunity to operate controls and test skills: instruments work, lights flash, and moving parts instruct on the principles of flight. Five wind tunnels, one an operable Collins wind tunnel, are used for demonstrations. Others instruct visitors on how to determine lift, drag and the comparative advantages of streamlined designs.

A Model B biplane of 1911, the Wright brothers' thirteenth aircraft, is suspended from the ceiling. The aircraft, completely restored, made its last flight in 1934 on the 31st anniversary of the Wright brothers' first flight.

A T-33 jet trainer is in the center of the Hall of Aviation where buffs may sit and operate the controls. Two Link trainers are nearby also for hands-on operation. A Boeing-Boelkow B-105 and a number of aircraft engines ranging from an early Anzani to the jet engines used to power Phantom jets are also on display.

More than 200 scale models ranging from early lighter-than-air craft to the Space Shuttle illustrate the evolution of manned flight in the air and in space.

The museum, occupying almost a full city block, has a science museum

and planetarium, a lecture hall, a lunch room and restaurant. It also houses the Benjamin Franklin National Memorial.

GODDARD SPACE CENTER (NASA)

GREENBELT, MD 20771. Tel: (301) 344-7000.
Hours: Wed–Sun 10 am–4 pm, closed Thanksgiving, Christmas, New Year's.
Admission: Free.
Publications: Free brochure.
Reproductions: Postcards and posters of museum exhibits and general space subjects.
Research: Library open to researchers by appointment.

The nerve center of the U.S. civilian space agency's worldwide satellite and communications system through eleven countries around the world is told at Goddard Visitors Center. Located at Goddard Space Flight Center about 15 miles from Washington, the center has exhibits of spacecraft and flight articles depicting the center's role in NASA's manned and unmanned missions since the launch of the Vanguard satellite in 1958.

Visitors can see a Delta satellite launching rocket and models of Mercury, Gemini and Apollo spacecraft; view a rock returned from the Moon by Apollo astronauts; learn how orbital weather stations and communications satellites telephone work; see the Amsat communications satellite facility; and find out about projected uses for scientific Earth satellites.

The center also shows how important computers have been to the Space Program. Goddard is one of the world's largest users of computers, compiling millions of digital bits of information from space every day.

Named in honor of Dr. Robert H. Goddard, the New England scientist recognized as the father of American rocketry, the center was the space agency's first major laboratory devoted entirely to the unmanned, scientific exploration of space, leading to significant roles in earth science, space application project management, spacecraft technology, satellite tracking and data processing.

The center also plays a part in space astronomy, solar studies, magnetic field and energetic particles research and applications of all weather and communications satellites.

INSTITUTE OF METEORITICS METEORITE MUSEUM

UNIVERSITY OF NEW MEXICO, ALBUQUERQUE. NM 87131.
Tel: (505) 277-2747.
Hours: Mon–Fri 9 am–12 pm, 1–4 pm, closed Sat–Sun and holidays.
Admission: Free.
Publications: Free brochure.
Reproductions: None.
Research: Geology library is subject to university rules.

The Meteorite Museum housed in the geology building of the University of New Mexico contains one of the world's most complete records of things

that fall to Earth. On display are the shards from over 350 meteor falls around the world, including the Norton County Meteorite, a specimen that fell into Kansas in 1948. No doubt it caused quite a commotion, since it weighs over a ton.

Its startling size aside, this meteorite and others like it are important clues for scientists studying the age and physical make-up of the universe. Almost all are composed of very complex igneous stone, some of it as much as 4½ billion years old. Their evidence suggests that the asteroid belt of our solar system—the source of most meteorites—was formed quite early in galactic history.

One means of studying these meteorites has yielded photographic images of striking beauty. Scientists make extremely thin slices of the rock and photograph the slices lit from behind. The resulting color photographs—many gorgeous in hue and detail—are also on display in the museum.

Another part of the museum's collection answers questions raised by folk astronomers for centuries. Every so often, someone finds shards of a very hard glass lying about in a field or on a slope. Such glass did not appear to be of human manufacture, and more puzzling still, it always appeared in strikingly aerodynamic shapes. For many years, it was believed that the glass was a mysterious element fallen from space. In a sense, it is. The shards, called tektites, were actually formed by the fall of huge meteorites, which melted the ground beneath them on impact, casting molten chunks out of the crater and into the upper atmosphere. These glassy chunks orbited the Earth until they were at last pulled back to the ground by gravity. One would think that such a violent reaction would be difficult to conceal, but one must keep in mind that the very youngest tektites left the Earth around 700,000 years ago.

INTREPID SEA—AIR—SPACE MUSEUM

1 INTREPID SQUARE, PIER 86 - 46TH STREET AND 12TH AVENUE, NEW YORK, NY 10036. Tel: (212) 245-0072.

Hours: Winter: Sun–Sat 10 am–5 pm, box office closes at 4 pm; Summer: Sun–Sat 10 am–6 pm, box office closes at 5 pm.

Admission: $6 adults, $5 senior citizens, $3 children.

Publications: Free brochure.

Reproductions: Posters, postcards, prints and slides of the museum and related subjects.

Research: None.

Unique among the nation's aerospace museums is the USS *Intrepid*, the famous aircraft carrier of World War II. It is tied up at Pier 86 on the Hudson River in New York City. Like its land-based counterpart, the U.S. Navy Aviation Museum in Florida, the *Intrepid* tells the story of naval accomplishments in aviation and space.

The USS *Intrepid* was launched in 1943 and was retired 30 years later. It became a floating aerospace museum in 1981. The ship's historical exhibits, displays and informational facilities are located on the hangar deck, where its aircraft were stored. Illustrated is the role of the US Navy in space as well

Visitors on the flight deck of the U.S.S. *Intrepid*, waiting to enter the control "island". The fighter plane is a Grumman F-11-F. Anti-aircraft guns are to the right.

as aviation. The *Intrepid* participated in the recovery of the Mercury 7 spacecraft in 1962 and retrieved the Gemini 3 with astronauts "Gus" Grissom and John Young aboard in 1965.

Visitors enter the carrier by means of stairs directly from the dock onto the hangar deck. At the entrance, a recorded tour narration can be rented. The tour begins at the Navy Hall in which the Carrier Operations Theater shows a film depicting life aboard the *Intrepid*. The theater is in the forward end of the carrier. After the film, visitors move toward the rear and into the Navy Hall proper. Here they view aircraft on the deck as well as suspended from the ceiling. These are arranged to give the appearance of being in flight. Other displays include optic boards. Then visitors also walk out to the platform upon which the astronauts were brought aboard. Still farther to the rear is the *Intrepid* Hall. In it, visitors learn the history of the ship itself, especially of its part in the epic battle of Leyte Gulf, the Philippines, the greatest naval battle of all time, in which the Japanese fleet was virtually destroyed. A multimedia presentation, "The Spirit of the *Intrepid*," and a series of dioramas make up the show. Tapes produce vivid sounds of the action.

From the *Intrepid* Hall,the visitors continue farther aft to the Pioneers Hall. In it, they see a collection of early films, photographs and wood and canvas planes that were associated with the early days of aviation during the 1930s. Last stop on the tour, and the farthest aft, is Technologies Hall. Once inside, visitors see and hear of the latest in space technology. In addition to the spacecraft on display, there are the most recent Navy guided missiles. Special films depict the story of the Apollo manned spaceflight project.

On the flight deck—longer than three football fields—a collection of aircraft is arranged as though about to be launched. Included among them are the Lockheed P-2 "Neptune" from 1945, McDonnel Douglas A-4 "Skyhawk," Grumman F-11 and a rare 1957 Grumman F-1 "Tracker" early warning plane. From the flight deck, visitors are able to visit the island which houses the control center and the admiral's and captain's bridges. Here visitors sit in the chairs used by the carrier's senior officers to direct combat operations during the battles of World War II.

In the various gun positions of the USS *Intrepid*, they can occupy gunner and loader positions in the various 13 gun mounts that protected the carrier against enemy planes. The guns include 5-in and 3-in weapons as well as the famous 20-mm "pom-pom" guns.

Future plans for the museum include the restoration of areas below the hangar deck to show typical living quarters, machine shops, mess halls and other working areas as they were during World War II. The sea, air and space story, now confined to the hangar deck, will be expanded into other areas with exhibits that show both its military and civilian aspects. Utilizing aircraft and artifacts from all military services as well as civil aviation and the merchant marine, topics will vary from amphibious operations to test flying, military sea transportation service and the story of the Polaris intercontinental guided missile.

LYNDON B. JOHNSON SPACE CENTER (NASA)

PUBLIC SERVICES BRANCH, AP4, HOUSTON, TX 77058.
Tel: (713) 483-4241.
Hours: Daily 9 am–4 pm, closed Christmas Day.
Admission: Free.
Publications: Free fact sheet.
Reproductions: Lithographs of shuttle and manned space missions among other reproductions.
Research: Library will respond to written request for information. It handles around 10,000 requests a month.

Johnson Space Center, focal point for all U.S. manned space flights, offers visitors an opportunity to see first hand activities of man's work in Earth orbit, on the Moon and ultimately beyond. Located 28 miles south of Houston, near Clear Lake City, the center features education programs as well as group and special tours. Throughout, there are clearly marked signs which lead visitors along the self-conducted tours.

The center developed the technology required for U.S. manned space flight, overseeing the design and manufacture of manned spacecraft. This center is also responsible for the selection and training of astronauts for U.S. missions and for managing the biomedical and scientific experiments performed in space.

Among the artifacts on display are several that performed missions in space. They are the Faith 7 Mercury, the Gemini 5 and the Apollo 17, the last of the craft to visit the Moon. Other displays of note in the history of astronautics are a lunar roving vehicle (the "Moon Buggy" of the Apollo

This assembled Saturn 5 Launch Vehicle was slated to be Apollo 18 or 19 but the program was discontinued after only six lunar landing missions. Foreground: models of Mercury Redstone, and Little Joe, far right.

astronauts), a lunar module, several samples of lunar rock and soil, and an Apollo lunar sciences experiments package, featuring scientific instruments left on the Moon by Apollo astronauts, along with various other spacecraft components such as engines, spacesuits and the mobile quarantine trailer in which the astronauts were isolated after returning from the Moon.

Outdoor exhibits include a Saturn 5 launch vehicle of the type used in Project Apollo and Skylab, a Mercury Redstone vehicle such as that which launched astronaut Alan Shepherd into space and a Little Joe vehicle used to test the escape rocket system of the Apollo spacecraft.

Of significance in the nation's history in space is the original U.S. copy of the Outer Space Treaty of 1967 and other memorabilia of President Lyndon B. Johnson, for whom the center is named.

At the mission simulation and training building, visitors see the Skylab trainers used to prepare astronauts for the historical mission that tested the technology for future American space stations. And a full-scale Space Shuttle trainer gives visitors an idea of how astronauts prepare for flights aboard the world's first reusable space craft.

Briefings are provided daily on operation of the mission control center, where all manned space flights are monitored from lift-off at Kennedy Space Center to splashdown.

Scientists can be observed at work in the lunar sample building where many of the 800 pounds of lunar rocks and soil returned to Earth are stored and tested.

THE KANSAS COSMOSPHERE & DISCOVERY CENTER

1100 NORTH PLUM, HUTCHINSON, KS 67501. Tel: (316) 662-2305.
Hours: Tues–Fri 9 am–4 pm, Sat 10 am–4:30 pm, Sun 12–4:30 pm, Eves Tues, Thurs, Fri, Sat 6–9 pm.
Admission: Free for Discovery Center; fee for Cosmosphere Theater.

Publications: Free brochure.
Reproductions: A postcard of the center.
Research: No research facilities.

Opening its doors in 1980, the Kansas Cosmosphere & Discovery Center, is one of the most advanced aerospace museums in the Midwest. It offers a wide range of services to the public, tourists and educators. The center has artifacts, reproductions and photographs that chart the development of America's space exploration program.

Upon approaching the center, visitors are initially impressed by an 3200-square-foot array of solar-energy collectors mounted on the roof. These devices collect energy to warm the center and provide its hot water, just as solar cells on space satellites provide electrical energy to power them. Thus, the center looks to the present as well as the future, already using the spinoff technology fostered by space science.

Among the space exhibits on display at the center is a 25-foot high replica of the Apollo lunar module, in which astronauts landed on, and departed from, the Moon. Also shown is a replica of the Explorer 1, America's first satellite, launched in 1958, as well as a replica of its competitor, Sputnik 1, the world's very first satellite. The center features one of the largest displays of spacesuits in the country, including early experimental models as well as those actually used in manned flight missions. Associated with this display is one designed to explain how personal hygiene was accomplished during spaceflight and how the astronauts slept. Another exhibit features space food and its preparation. In one of the "hands on" exhibits visitors may try on an actual space helmet.

Certainly the most exciting and one of the most informative facilities of the center is its 107-seat W.D.P. Carey Cosmosphere Theatre. In it, the audience is seated on an inclined floor while film is projected on a hemispherical screen above it. Two of the most popular shows are "Genesis" and "To Fly"—the first about Earth's formation and the second about the experience of flight. A special, 6-channel stereophonic sound system designed in Hollywood provides added realism to the film.

Services provided by the center to the public, students and school teachers include a musical laser light show in the evenings and a live science demonstration during the weekdays called the "Space Traveler's Survival Workshop."

KENNEDY SPACE CENTER TOURS

VISITORS CENTER, TWA-810, KENNEDY SPACE CENTER, FL 32899.
Tel: (305) 867-1566.
Hours: Daily, 8 am–2 hours before dark, closed Christmas Day.
Admission: Free. Admission charge for bus tours only.
Publications:
Kennedy Space Center Tour Book. nd, $3.75.
Space Shuttle. nd, $3.75.
Reproductions: Large selection of posters, prints, postcards, slides and other reproductions about the space center and related subjects.

Research: Educator's Resource Library available to teachers. Copies can be made of printed matter, slides and videotapes of archival material.

Visitors to the central Florida area will find one of the best aerospace information centers and museums within an hour or so drive of Disney World and Epcot. It is the NASA Kennedy Space Center's Tour and Visitors Center.

The most popular feature of the Visitors Center are its two guided bus tours. The red tour covers the Kennedy Space Center in detail, while the blue tour goes through the U.S. Air Force Museum, at nearby Cape Canaveral Air Force Station (see p. 000). Both tours originate at the Visitors Center.

Among the highlights on the red tour is the Operations and Checkout Building, largest building in the center, in which payloads for the Space Shuttle and the Spacelab are prepared. Also visited is the Flight Crew Training Building, which is occupied by the engineers and technicians who work on the complex system used to launch the Space Shuttle. Inside this building, too, are the spaceflight simulators that were used to train the Apollo astronauts for their missions to the Moon.

They are the command module simulator and the lunar module simulator. On first seeing the command module simulator, the visitor will understand why astronaut John Young referred to it as the "the great train wreck." Inside it, three astronauts operated controls in response to flight problems and emergencies created by engineers sitting outside at control panels. Outside the windows of the the command module, the astronauts saw exactly what they would see from lift-off to landing on the Moon and return to Earth. Looking no less like a "great train wreck" is the lunar module simulator. It was used by the two astronauts who landed on, and returned from, the Moon.

Also in this building is a lunar module that is not a replica. It is an operational vehicle, capable of flight, if needed. It is displayed on a simulated lunar site, with a spacesuited mock astronaut saluting the American flag amidst a deployed Apollo Lunar Exploration Scientific Package and a Lunar Rover.

The most impressive sight on the red tour is the Vehicle Assembly Building. This structure is 525 feet tall, covers 8 acres, and has an inside volume of 129,000,000 cubic feet, making it among the world's largest buildings. Today, the Space Shuttle is assembled in it. During the 1960s, the gigantic Saturn 5 rocket and Apollo spaceship were prepared for launch inside it. Outside the building, the visitor sees the 363-foot-tall Saturn Apollo vehicle, stretched out on its side. Also on view is the mobile launcher used to send astronauts to the Skylab space station in 1973 and 1974, and the American astronauts to join Soviet cosmonauts in space in 1975. Also displayed are the huge crawler transporters that move the assembled Space Shuttle from the Vehicle Assembly Building to its launch pad three-and-a-half miles away. When operational conditions permit, the red tour drives around the launch pad. It was from this same pad that the astronauts of the

the Apollo lunar missions were launched. The tour also passes a landing field for the Space Shuttle, 15,000 feet long and 300 feet wide.

While waiting for tour buses to depart, visitors will find much to see in the Visitors Center and the grounds around it. Guided walking tours begin periodically in the spaceport, across from the information counter in the Visitors Center. They take about 30 minutes. However, visitors are at liberty to take in the center on their own. One of the more interesting things in the center are the space science demonstrations in Theater No. 1. These are presented by professional space educators or technicians and cover a wide range of topics from how spacesuits operate to the principles of liquid propellant rocket propulsion. Theater No. 2 continuously presents a variety of space movies, each lasting between 15 and 30 minutes.

The focus of the Center is on a special memorial to all those individuals who have given their lives for the advancement of space exploration. Other exhibits give the visitor an opportunity to stand in the Lunar Module Simulator, have his picture taken with a spacesuited "astronaut," sit in a Lunar Rover and view the story of communications satellites. Of special interest are those samples and exhibits of "spinoffs" from the space program. These spinoffs are products derived from space technology that include improved protective suits for firefighters, rechargeable heart pacemakers, improved surgical implants and cooler running, longer lasting automobile tires.

In the rocket park next to the Visitors Center are several historic space launch vehicles. The largest of these is the Saturn 1B, which sent the first three-man Apollo spacecraft into Earth orbit, testing it for future trips to the Moon. It later sent astronauts to the Skylab space station and to the rendezvous and docking a Soviet Soyut mission.

Other launch vehicles include the early Juno 1, which launched America's first satellite; the Juno 2, which launched some of the nation's first space probes; and the manned-spacecraft launchers Mercury Redstone, Mercury Atlas, and Gemini-Titan 2. Booster rockets for unmanned satellites displayed are the Delta and Atlas Agena. In addition to these vehicles, there are two liquid-propelled rocket engines of the Saturn 5 vehicle that sent the Apollo astronauts to the Moon.

Equally interesting artifacts of early manned spaceflight include the access arm from the Apollo launcher which the astronauts crossed in order to enter their Apollo spacecraft once it was in place on launch pad No. 39. Exhibited also is a "dish antenna" used from 1959 until 1975. This telemetry antenna received signals during early unmanned missions as well as manned missions. Throughout a launch, it received data indicating the rocket's speed and direction.

The rocket park also has an interesting souvenir from the Apollo 14 lunar landing mission of 1971. It is the "Moon tree," a sycamore grown from a seed taken to the Moon and returned by astronauts Alan Shepard and Edgar Mitchell. The tree was planted as a part of the bicentennial celebration in 1976.

From the Visitors Center and its rocket park, visitors move to the Gallery

of Space Flight. Here the history of spaceflight is depicted primarily with flight "hardware," models and photographic displays.

As in many NASA centers, the featured exhibit is a rock returned from the Moon by Apollo astronauts. An Apollo spacecraft is also shown, but it is not one that went to the Moon. It is the historic craft in which American astronauts and Soviet cosmonauts met in space during the 1975 Apollo-Soyuz Test Project, and includes a full-scale replica of the docking adapter. Other spacecraft shown are a test module of a Mercury and the Gemini 7 in which astronauts Borman and Lovell orbited Earth for 14 days in 1965. Displayed with them are spacesuits worn by Gemini and Apollo astronauts. Of the several models of space vehicles, the most impressive is a 1:10 scale replica of the Saturn 5. This model is cut away to show internal structural details of the rocket. An unmanned space probe of equal interest is a full-scale model of the Viking lander on a simulated Mars site, where two of them touched down in 1976.

Inside the Galaxy Center (open in 1984), near the Orbit Cafeteria, is located one of the few IMAX, large-screen movie systems in the East. This unique movie projection system utilizes a hemispherical, overhead screen instead of the conventional flat screen in front of the audience. With Imax, the audience sits in seats that are inclined backward. Special space films are projected, and there is a complex stereo sound system.

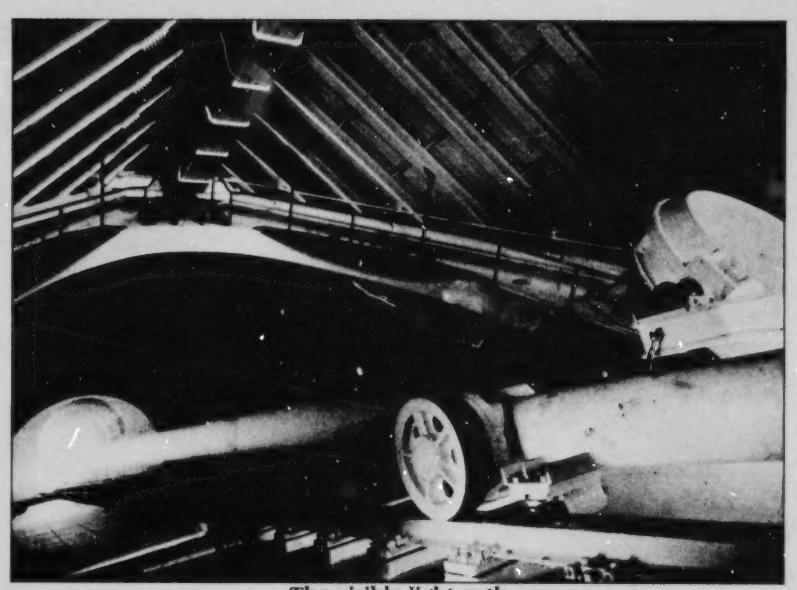
The Kennedy Space Center is located across a causeway from Merritt Island. Most of the land on the island is part of a national wildlife refuge. The visitor interested in nature can view a rich variety of wildlife that lives in harmony with the nation's largest space launch vehicles. For example, the red bus tour passes a rare nest of the American bald eagle, which has been in the same place for years. Among the 200 species of birds that make their home on or near the Kennedy Space Center are spoonbill, Louisiana, great blue and green herons, wood ibis, various egrets and the brown pelican. Among the many nonairborne denizens of Kennedy Space Center are the alligator, armadillo and the black-footed ferret.

KITT PEAK NATIONAL OBSERVATORY

PO BOX 26732, TUCSON, AZ 85726. Tel: (602) 623-5796, x250.
Hours: 10 am–4 pm daily, closed Christmas Eve and Day, and when weather closes road.
Admission: Free.
Publications: Brochures. Film about observatory available for rental.
Reproductions: Poster.
Research: None.

Some 56 miles southwest of Tucson, 7000 feet up in the Quinlan Mountains above the Sonoran desert floor, is a cluster of astronomical telescopes that look to the visitor like a set for a science fiction movie.

The Kitt Peak National Observatory furnishes astronomical facilities for 16 major universities in the United States. It is operated by the Association of Universities for Research in Astronomy for the National Science Foundation. Kitt's Peak is a window on the universe, containing the largest collection of



The visible light path
of the Sun at the McMath
Solar Telescope.

optical research telescopes in the world. For years it has been the focus for Earth-based observational research of the astronomical study of our solar system.

The Kitt Peak Observatory has one of the most diverse collections of astronomical observing instruments in the world. The most impressive of these is the Mayall 4-meter telescope—one of the world's largest. Astronomers from all over the world come to use it. In addition to night-time observations, the Mayall telescope can be used during the daytime for infrared observations. It is designed primarily for observations of celestial objects at low-light levels. Thus, it is useful for gathering data on quasars and galactic clusters. It has been utilized to search for new planets and for black holes, and to help determine the rate at which the universe is expanding. It is housed in a dome 186 feet tall, almost 18 stories high. There is a visitors' gallery within it, but visitors are not permitted to view celestial objects through the telescope.

Also located at the Kitt Peak Observatory is the world's largest Sun telescope, the McMath Solar Telescope. From the visitor's booth, one can see images of the Sun that are gathered at the surface end of the telescope and transmitted down a 500-foot shaft to a viewing room beneath the earth. So versatile is the telescope, it can also be used to study the Moon, planets and some of the brighter stars. Adjacent to the McMath telescope is another one used for studying the Sun. It is the Vacuum Solar Telescope, housed in a 75-

foot high tower to make daily magnetrograms of the Sun's activity. The light from the Sun travels through a large vacuum tube to prevent its image from being disturbed by air currents. Knowledge gained from this telescope was used by the National Aeronautics and Space Administration to inform the astronauts on the Skylab space station of solar activity so that they could train their space-borne telescope on the Sun.

Also available to the visitor is the 84-inch telescope, one of the world's largest, used primarily for observation of celestial objects emitting radiation beyond the wavelengths of visible light. This 46-ton telescope is used for research by studying their infrared radiation of objects as well as observations of the nebulae in other wavelengths.

Other instruments of significance are the 30-centimeter Schmidt telescope, of the type used to photograph Earth satellites and establish their orbits.

Kitt Peak also houses several telescopes of the University of Arizona and a radio telescope operated by the National Radio Astronomy Observatory. Although not open to the public, these can be seen from the outside.

At all points along the tours, the direction for which are available in a brochure in the visitors center, views of the terrain below the observatory are well worth photographs, and cameras are welcome.

Both self-guided and guided tours are available from the visitors center. By special arrangement a group tour can also be accommodated if it numbers 15 or more. However, reservations must be made by telephoning or writing to the observatory.

The observatory has a film rental service for schools and other organizations, and a list of titles and charges are available upon request.

LANGLEY RESEARCH CENTER (NASA)
NASA Visitor Center

FREEMAN ROAD, MAIL CODE 480, HAMPTON, VA 23665.
Tel: (804) 865-2855.
Hours: Mon–Sat 8:30 am–4:30 pm, Sun 12–4:30 pm.
Admission: Free.
Publications: None of a popular nature. Scientific documents available.
Reproductions: Slides, laser prints and postcards of space subjects; also a kit for building a full-sized, two-seater airplane.
Research: Technical library available to students and general public.

A full-scale engineering model of the Viking test lander, the incredible robot laboratory that landed on Mars in 1976, and an Apollo moon-girdling command module are the centerpieces of space displays at the Langley Research Center. Other exhibits carry visitors on the long trip from Kitty Hawk to Mars, thus spanning the histories of aeronautics and astronautics.

Artifacts of astronautical history and research include a Mercury capsule, the Apollo 12 command module and the spacesuit worn by astronaut Alan Shepherd, who commanded it. (One of the ubiquitous moon rocks is also on display.)

Although research emphasis at Langley is more keyed to aeronautics, its

mark in space science is evident through its early research in the Echo satellite, a pioneer in today's communications satellite networks and the Lunar Orbiter, which mapped the Moon prior to man's first lunar landing.

Viking, the orbiters and landers sent surface pictures of Mars, information on its soil chemistry and other environmental information. These provide a special presentation of the center.

Showing visions of America's future space exploration, exhibits detail designs of huge, orbiting structures that will one day house scientific research facilities and their operating personnel.

Langley Research Center features special monthly programs that are of interest to both the public and students of aeronautics and astronautics. Special films, slide shows and guest speakers provide the latest information on topics such as the latest space shuttle mission, advanced aircraft design, careers in aerospace fields, technology utilization of space advances, ultralight aircraft and home-built airplanes. Also included are topics of historical value, with programs on the development of aviation and space exploration.

LAWRENCE HALL OF SCIENCE

CENTENNIAL DRIVE, UNIVERSITY OF CALIFORNIA,
BERKELEY, CA 94720. Tel: (415) 642-5132.
Hours: Daily 10 am–4:30 pm, Thurs 10 am–9 pm.
Admission: Weekdays: $1 general; weekends: $2.50 adults, $1.50 students and senior citizens, $1 students under 18; free to children under 7.
Publications: Free brochure.
Reproductions: Postcard of the hall.
Research: Educational research facility for the staff.

Located on the campus of the University of California, the Lawrence Hall of Science offers a variety of services and exhibits that are of interest to the general public but of even greater interest to students and teachers of the astronomical and aerospace sciences. Its astronomy and physics education project specializes in developing, evaluating and disseminating ideas and techniques in science education for children and adults. The Lawrence Hall has developed a four-fold, educational approach.

The first effort consists of a series of innovative planetarium programs and workshops that encourage audience participation. It is built largely around the William K. Holt Planetarium in which visitors take part in observations, experiments and discussions. The most imaginative of these public programs is "Stonehenge." Built upon Salisbury Plain in England some 4500 years ago, Stonehenge, a structure made of concentric circles of huge stones, long puzzled scientists. Using individual markers, visitors view projections of the great stones to test the theory that Stonehenge is an ancient observatory, constructed to record the rising and setting of the Sun, Moon and certain stars. Other audience participation shows include "Constellations Tonight," "Colors in Space" and "The Red Planet Mars."

The second approach is through discovery activities for the use of organized groups such as scout troops, summer camps or classes. They are designed to allow the students to extend the scope of the activity by building

models, preparing experiments and holding group discussions. Typically these activities include areas as diverse as classical and modern astronomy, model rockets, solar energy and digital electronics. Among the most helpful of the instructional aids developed for these activities is the "Sky Challenger." It is a star finder with interchangeable discs, each with a different game or challenge on it. With it, one can locate planets, test his eyesight, locate stellar constellations above North America and tell time by the stars.

The third approach offers visitors the chance to investigate science on their own, with no formal course. It has programs designed to increase interaction between the individual and exhibits in the hall. Featured among these is "Star Games: Discover Astronomy." This game permits the visitor to use a real telescope to explore a simulated sky, observe the optical effects of Earth's atmosphere, chart the spectra of various stars and listen to radio transmissions from a pulsar.

The fourth approach is aimed at the planetarium and science teacher, offering a series of workshops tailored to the needs of such educators. They are generally interdisciplinarian in scope.

The staff also works upon a number of other projects of service to educators, primarily but not restricted to the astronomical sciences. Typical of these areas are television education, science-humanities interaction and computer-assisted education.

LEWIS RESEARCH CENTER (NASA)

21000 BROOKPARK ROAD, CLEVELAND, OH 44135.
Tel: (216) 267-1187.
Hours: Mon–Fri 9 am–4 pm, Sat 10 am–3 pm, Sun 1–5 pm, closed Thanksgiving, Christmas, Easter, and New Year's.
Admission: Free.
Publications: Free brochure.
Reproductions: None.
Research: No library; technical research facilities for engineers and scientists.

A lead facility for NASA's aeronautical and alternate energy research and development, the Lewis Research Center is located in the port city of Cleveland. Its visitor information center is designed to reflect the institution's role in research and has displays concerned with both aeronautical and astronautical projects, as well as with energy programs featuring the development of more efficient windmills. Among the significant space exhibits is a moon rock brought to Earth by the astronauts of the Apollo lunar exploration program.

The center has a large lecture hall and 150-seat theater for special presentations to groups. Of particular interest to educators is the teachers' resource room. It is reserved exclusively for the purpose of providing a variety of materials to teachers. Among the resources available are an extensive slide, tape and film library; special NASA and Department of Energy publications; lesson plans; and facilities for copying slides and audio tapes. There is no fee for these services although the teacher must provide film and blank tape cassettes for copying purposes.

In an overview of space exploration, the museum has exhibits concerning the Skylab spacesuit, breakthroughs from manned and unmanned space flights, and the Space Shuttle, including information about crew accommodations, launch vehicles and mission capabilities as well as about Lewis Center's role in shuttle development.

Space materials research is also presented, showing how such materials are tested and developed to withstand space conditions and other environmental extremes. Space-age technology, much of it developed by Lewis, is also exhibited, including nonspace spinoffs such as a heart pacemaker, portable antennas, rescue equipment and identifiers for the blind.

METEOR CRATER MUSEUM OF ASTROGEOLOGY

6 MILES OFF INTERSTATE 40, FLAGSTAFF, AZ 86047.
Tel: (602) 526-7175.

Hours: Summer: Sun–Sat 6 am–6 pm; Spring and Fall: Sun–Sat 7 am–5 pm; Winter: Sun–Sat 7:30 am–4:30 pm.
Admission: $4 adults, $3 senior citizens, $2 children 12–17, $1 children 6–12, free under 6.
Publications: Free brochure.
Reproductions: Postcards.
Research: None.

This is a museum with a spectacular setting. In the distance, one sees the San Francisco Peaks and the Hopi mesas, and the building perches on the edge of what was once thought to be a simple butte. In fact, it lies on the north rim of a meteor crater ¾ of a mile across and 570 feet deep.

The meteor that did the deed was a young one. Most "falling stars" struck the earth between 250 and 750 million years ago; this one arrived a mere 25,000 years ago. It entered the atmosphere traveling around 45,000 miles per hour and touched down with the force of a fifteen-megaton atomic bomb, scattering debris more than 20 miles around.

The site itself is impressive, but the museum does an unusually good job of interpreting it. Divided into seven sections, the exhibits first introduce the visitor to the origins of meteors in general. Most come from the asteriod belt, but a few also come from deep space, propelled by a force like the far-off explosion of a star. The second section details the origin and impact of the Meteor Crater meteor, displaying fragments of it, one of which weighs over 1400 pounds. Most meteors and meteorites burn up in the atmosphere, but others—like this one—have a high density of metals like iron and nickel, and so are able to reach the Earth with their cores intact. (In fact, it was a mining engineer's acuity that led to the discovery of the crater. He wanted to mine the crater for the main body of the meteor, not realizing that 80 percent of it had vaporized in the atmosphere, falling as rain.) A five-minute film, mixing live-action and animation, shows the impact and its effect on the local geology.

A third section of the museum discusses the 32 other proven crater sites and 29 suspected ones, comparing them with the Meteor Crater site. Other

The meteor crater site near Flagstaff, Arizona. The museum proper is located at the edge of the crater, far left.

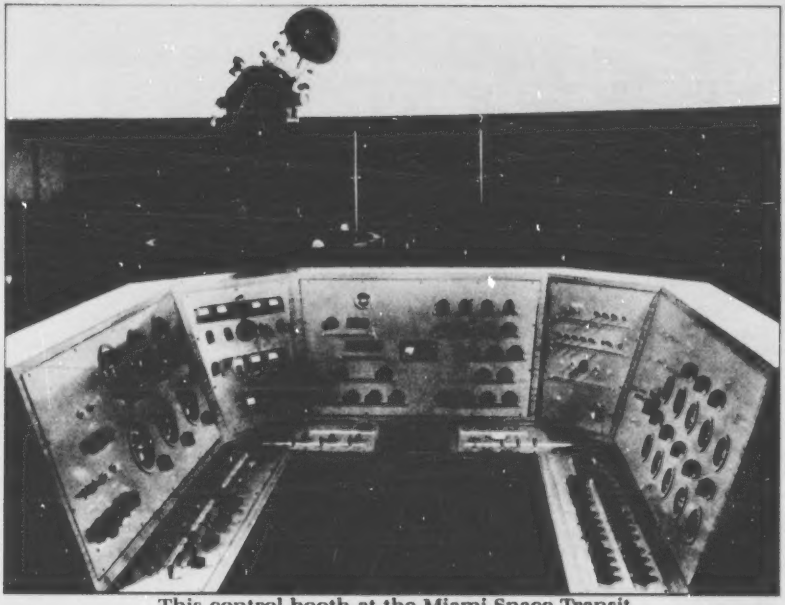
sections compare Earth's craters with the Moon's, pay homage to American astronauts, and display pictures sent back by Voyager and Viking missions of the surfaces of other planets.

Outside, there is a full-scale Apollo capsule, one of those used to test the flotation collar for splashdown, but the real star is the crater itself. Visitors can walk along the rim and stroll out on a bridge that extends towards the center of the crater. There, one finds a telescope for close scrutiny of the bottom.

The general public isn't allowed to descend into the crater itself, but groups of persons with interest in geology or astronomy can apply for permission to take a guided tour.

MUSEUM OF SCIENCE AND SPACE TRANSIT PLANETARIUM

3280 S. MIAMI AVENUE, MIAMI, FL 33129. Tel: (305) 854-4242.
Hours: Sun–Thurs 10 am–6 pm, Fri–Sat 10 am–10 pm.
Admission: $1.50 adults, $1 children under 13 and senior citizens.
Publications: Bi-monthly newsletter and free brochures.
Reproductions: Some postcards of subjects related to the exhibits.
Research: Reference library open to members and visiting scientists by appointment.



This control booth at the Miami Space Transit Planetarium can be used by members of the audience to simulate the docking of two orbiting spacecraft.

Established in 1949 as a children's museum, Miami's Museum of Science moved to its present site in 1960, expanding its programs to include adults. The more than 100 exhibits creatively present the properties of light and optics, sound, chemistry, biology, physics and energy. Natural history exhibits, in addition, feature animated dioramas, slide shows and continuously running films.

The greatest attraction of the museum, however, is certainly its 65-foot planetarium dome. The Space Transit Planetarium is the largest of its kind, and its staff has been instrumental in developing some of the world's most popular sky shows. "Child of The Universe," produced at the Miami museum, is the longest running and most acclaimed planetarium show in the world. It shows the history of the universe as conceived by various astronomers, ancient and modern. Just recently, the planetarium has produced "Starbound," a show that simulates future modes of space travel.

Though it shows all kinds of planetarium programs—together with the popular laser shows—the ability to simulate actual space travel is what makes this facility remarkable. Watchers can orbit the Earth or any of the other planets, seeing what the planets look like from close or far. Members of the audience can operate controls to dock two orbiting space craft! And the planetarium can even show how the night sky would look from the surface of any of the planets.

NATIONAL AIR AND SPACE MUSEUM

INDEPENDENCE AVE BETWEEN 4TH AND 7TH STREETS, SW, WASHINGTON, DC 20560. Tel: (202) 357-1300.

Hours: Labor Day–March 31: 10 am–9 pm; Apr 1 through Labor Day: 10 am–5:30 pm; closed Christmas.

Admission: Free.

Publications:

C.D.B. Bryan, David Larkin, *The National Air & Space Museum*. 1979, $60.

Reproductions: Posters, prints, postcards and slides of air and space subjects.

Research: Teacher resource center available to educational community.

Abraham Lincoln could hardly have perceived the significance of a request from Joseph Henry, first secretary of the Smithsonian Institution, who in 1861 suggested that balloonist Thaddeus Lowe be permitted to demonstrate a manned balloon ascension in order to illustrate its potential for military observation purposes. Over a century later, the Smithsonian's air and space museum shows the astounding range of inventions developed since that time.

The National Air and Space Museum can be said to have had its beginnings in 1876, when a collection of Chinese kites was donated to the institution following the world's fair of that year in Philadelphia. Its mission is simply to present to the public the history of aeronautics and astronautics in a manner that is clear, understandable and enjoyable. Emphasis is placed upon the communication of highly complex technical and scientific information to citizens.

An array of aircraft and spacecraft in 23 exhibit areas present artifacts ranging from the Wright brothers' original 1903 Flyer and Lindbergh's "Spirit of St. Louis" to the Skylab Orbital Workshop, the Freedom 7 and Apollo 11 spacecraft, and the Mars Viking lander.

Visitors can walk through documented major aerospace achievements, both historical and technological, and view dozens of missiles and rockets, engines, propellers, models, uniforms, instruments, flight equipment, medals and insignia. All aircraft and spacecraft were either actually flown or used as backup vehicles, unless specifically labeled otherwise.

The impressive entrance gallery features the Kitty Hawk Flyer, the "Spirit of St. Louis," the X-15, John Glenn's Mercury spacecraft, Apollo 11, the first moon landing "Columbia" command module, Pioneer all suspended from the ceiling or stationed about the floor. (How do they get such huge exhibits into the building? Gigantic doors on the west side admit them.)

The story of air transportation is recounted with the Pitcairn Mailwing, Northrop Alpha, Ford Trimotor, Fairchild FC-2, Boeing 247, and the Douglas DC-3 planes. The fascinating aspects of vertical flight are seen with the first Presidential helicopter, a combat assault helicopter, autogiros, and home-built gyrogliders.

Recently restored aircraft include the Curtiss P-40, a World War II fighter; the Grumman Fieldhawk II, an aerobatic airplane; the P-51C Excalibur III, a record-setting Mustang; and the P4U Corsair.

Objects on display include Scout, Vanguard, and Jupiter-C launch vehicles. The Skylab Orbital Workshop and the V-1 "Buzz Bomb" are in the background.

The first 40 years of jet aviation are displayed in galleries featuring the Messerschmitt Me 262, the world's first operational jet fighter; the Lockheed P-80; the FH-1 Phantom; and the Bede BD-5J.

The Wright 1909 Military Flyer, the world's first military airplane, a 1908 Rinek Voisin, a 1911 Curtiss Pusher, and a 1911 Bleriot Tractor Monoplane commemorate the indoor aeronautical exhibition of 1913.

Decorating the Independence Avenue lobby are aeronautical and astronautical trophies and two large wall murals—Robert McCall's "The Space Mural—A Cosmic View" and Eric Sloane's "Earth Flight Environment."

For those interested in the historical evolution of flight research aircraft and testing, the artifacts of "Winnie Mae," the Bell XP-59A Airocomet and the Hawker Siddeley XV-6A Kestrel provide an intriguing insight.

In the sea-air operations gallery, a reproduction of an aircraft-carrier hangar deck, including artifacts of the Boeing F4B-4, "Wildcat," "Dauntless" and "Skyhawk" give visitors a feeling of some of the sensations of flight at sea. Nearby, the aviation history of World War II is featured, including a Messerschmitt Bf 109, the "Spitfire," "Zero," Macchi 202 and the P-51 "Mustang."

A diorama of the capture of a Fokker D-VII near the end of World War I is featured in an adjacent gallery. Here also, are artifacts of the Fokker D-VIII, a SPAD VII, General Billy Mitchell's SPAD SVI, and the Albatros D.VI.

Important solo-flight or prototype planes include the "Gossamer Condor," the Douglas "World Cruiser," Lindbergh's Lockheed "Sirius," Curtiss R3C-2, and Wright's "Vin Fiz." Amelia Earhart's Lockheed "Vega" and a commemorative Lindbergh exhibit offer significant artifacts of aviation's formative years.

The story of lighter-than-air flight is depicted with models of the Montgolfier balloon and the dirigible *Hindenburg*. The gondola of the "Double Eagle II," the first balloon to successfully cross the Atlantic, is also on display.

The museum houses many pictures, rockets and artifacts of Dr. Robert H. Goddard, the father of liquid-propellant rocketry in America.

Three automated puppet shows make simple work of explaining the fundamentals of airplane design, jet engines and modern space technology, including 100 audio-visual and special effects units, ranging from flying one's own airplane to orbiting the planet Mars.

"Descent to Venus," an exciting video simulator, carries visitors aboard a spaceship around the year 2150 for a close-up view of the planet. Another show features fact and fantasy of space flight from the thirteenth century to the present, with exhibits ranging from simple rocket motors to a model of the *Enterprise* from television's popular show "Star Trek".

The story of U.S. manned space flight programs, from project Mercury through Apollo, Skylab, and Apollo-Soyuz, is illustrated by the Mercury "Freedom 7," Gemini 7, Apollo 11 spacecraft, lunar roving vehicle, Skylab, and Apollo-Soyuz command and service module—from the only joint U.S.-U.S.S.R. venture into Earth orbit. There are also moon rocks and models of the Space Telescope and Spacelab. Early unmanned Sputnik I and Explorer I, satellites that initially set off the space race between the two nations, are also on display.

Spacesuits make up a historic display, including those of Alan Shepard, the first American in near space; John Glenn, the first American to orbit the Earth; Neil Armstrong, the first Moon walker; Edwin Aldrin, another Apollo II moon walker; and Eugene Cernan, an Apollo 17 crew member.

Visitors can learn more of the planets and Moon by exploring the Voyager, Pioneer Venus orbiter, Lunar Orbiter, Ranger, Surveyor and Viking. They can also browse through more than 200,000 photographs and images of Earth, the Moon and the planets and a rare book collection at the Center for Earth and Planetary Studies.

In the Albert Einstein Spacearium, the visitor can view the universe as it is seen by space-age astronomy, venturing into the realm of black holes, exploding stars and quasars, seeing the scorched surface of Venus, Jupiter's Galilean satellites or the beautiful ringed planet of Saturn.

A Carl Zeiss Model VI planetarium instrument accurately projects some 8,900 stars as well as the Milky Way, nebulae, star clusters, the five visible planets, the Sun and the Moon and eclipses, comets and even wispy night clouds. By means of it, the visitor can view the Earth as seen from orbit.

Headphones provide narration in French, German, Spanish and Japanese.

The Samuel P. Langley Theater has 486 seats and utilizes an IMAX projector to show films on an overhead screen 50 feet high and 75 feet wide. The theater can also show standard movies and slides as well as multimedia presentations and can present lectures by individuals.

Special tours carry guests to the Paul E. Garber Facility, a museum in Suitland, MD, where aircraft and spacecraft are restored for display. Visitors can observe expert craftsmen at work on future exhibits. The German Messerschmitt Me 262, the first jet fighter in the world manufactured by Germany in 1944, was restored there. Also on display are the SPAD XIII, a World War I fighter aircraft similar to one flown by Captain Eddie Rickenbacker; the Curtiss JN-4D "Jenny", the World War I trainer made famous by post-war barnstormers; the North American F-86A, the best American fighter aircraft in the Korean War; and the Hawker "Hurricane II-C," the World War II British fighter used in the Battle of Britain.

For the scholar researching the history of aeronautics or astronautics, the museum has a modern library on the third floor. The nucleus of the library is a collection of more than 24,000 books; thousands of technical reports, documents, and magazines and many photographs, films and slides. Additionally, there is an extensive collection of rare books relating to the development of the aeronautical and astronautical sciences.

The museum also has a teacher resource center for the educational community, offering a variety of aeronautical and astronautical teaching materials. In the center, teachers can review such material and develop classroom teaching aids suited to their needs. A special briefing room is also available for groups of up to 50. Two programs are offered for students of grades 4 through 12. One is entitled "What Makes an Airplane Fly?" and the other is "How We Explore in Space." These are presented daily from Tuesday through Friday in the morning.

NATIONAL RADIO ASTRONOMY OBSERVATORY

PO BOX 0, SOCORRO, NM 87801. Tel: (505) 772-4255.
Hours: Sun–Sat 8:30–dusk.
Admission: Free.
Publications: Free brochure and larger publications:
National Radio Astronomy Observatory. 1982, $2.
Very Large Array. nd, $1.
Reproductions: Pictures available through NRAL headquarters in Charlotte, VA.
Research: Not open to public. Research facilities available to staff and visiting scientists actually using telescope.

Looking as though it should be at Cape Kennedy rather than on the San Augustin plains of western New Mexico near Socorro, the Very Large Array Radio Telescope Facility is nothing if not very large. Indeed seen from the air it appears to be a letter Y with two arms 13 miles long and a stem 11.8 miles long. Because of its remoteness only visitors dedicated to astronomy are likely to tour it, but the facility is worth the drive from Socorro to anyone

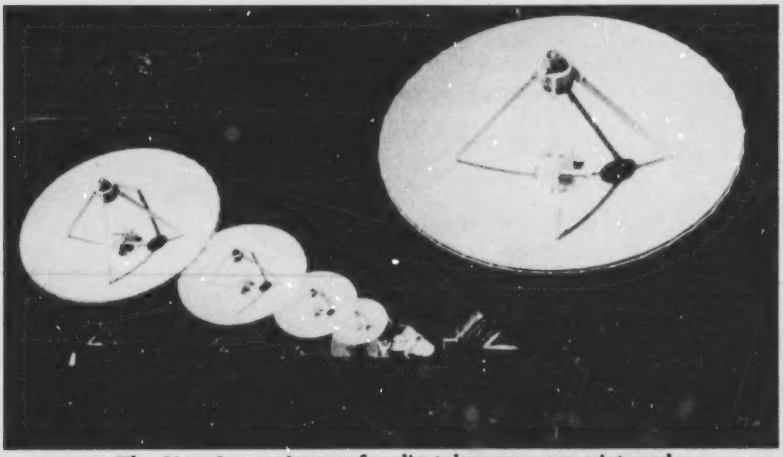
interested in astronomy and aerospace technology because of the immense size, scope and complexity of the establishment.

Basically the facility is an array of large, radar-like telescopes that can be arranged in geometrical patterns to study the radiowave emissions from very distant galaxies. The facility is in this remote area because it is one of the few locations in the country where such an obseratory could be accommodated in an environment relatively free of electromagnetic radiation.

Twenty-seven of these antennas are transported to 72 various locations along the Y-shaped railroad track. The arms and stem consist of two standard-gauge railroad tracks 18 feet apart. Each antenna weighs 210 tons and has a reflector 82 feet in diameter. The antennas receive very weak radiowaves from distant objects, amplify them 1,000,000 times, and transmit them to a control building for processing and analysis by computers for astronomers.

Among the other major elements of the facility visible to visitors is the ten-story assembly building in which the giant antennas are put together and maintained. Associated with the assembly building are two transporters that also seem to be something more appropriate for Cape Kennedy than the New Mexican desert. Weighing 65 tons, the transporters can move loads of 300 tons at speeds of somewhat less than 5 miles per hour. The transporters can completely rearrange the configuration of the 27 antennas in a day or two to meet new observational missions.

The control building, which is the nerve center for the facility, has a parking area for visitors as well as a gallery that runs its length, permitting visitors to view operations without interfering with them. Walking along the gallery, they can see the electronics room, control room and computer



The Very Large Array of radio telescopes are pictured stretching to the horizon. They are moved along the railroad track in the foreground to position them for observations.

room. From the gallery, the array itself can also be seen as well as the assembly building.

The electronics room contains the equipment that receives the signals from the antennas and processes them before they are sent to the computers. In the computer room are the data processing equipment necessary to reduce data and send commands to the antennas. The four central processing units have names that may seem whimsical if not unscientific to the general visitor: Boss, Monty, Cora, and Corbin. The functions of the control room are obvious: command and control of the array and monitoring of its observations.

NATIONAL SPACE TECHNOLOGY LABORATORIES

PUBLIC AFFAIRS OFFICE, NSTL STATION, MS 39529.
Tel: (601) 688-2377.
Hours: Sun–Sat 9 am–4 pm, closed major holidays.
Admission: Free.
Publications: Free brochure.
Reproductions: Postcards of the laboratories.
Research: Reference library open to public; it is helpful to call ahead: (601) 688-3244.

One of the smaller of the National Aeronautics and Space Administration's visitors centers, this one features the theme of "Space-Oceans-Earth." Located on the National Space Technology Laboratories installation near Bay St. Louis, the visitors center depicts the role played by the laboratories in space, oceanography, remote sensing and environmental projects. While the

The visitor's center of the laboratories features an architecturally unique observation tower. The rocket, right, is a scale model of the Saturn 5.

laboratories are best known as a test facility for the Space Shuttle engines, they are also home for scientific and technical groups from 17 federal and state agencies, including three universities.

The visitors center is easily recognized because of its unique architecture, a tower like a ship's bridge rising above the flat, Mississippi coastal plain. In front of the center is a 1:10 scale model of the Saturn 5 moon rocket, the engines of which were test fired at the site during the mid-1960s.

Within the Center displays, films and audio-visual presentations as well as models illustrate the laboratories' current projects for the space agency along with other resident agencies. Typical of these is a scale model of a Space Shuttle suspended from the ceiling in a simulated orbital position. Also hanging from the ceiling is a section of a structural member that could be produced in space for building large space stations. Other exhibits include an H-1 liquid propellant rocket engine which powered the first stage of the Saturn 1B launch vehicle used by the crews of Skylab. Youngsters have the opportunity of trying on a real space helmet of the type used by American astronauts. Also prominently displayed is a hydrogen-oxygen fuel cell powerplant used in the Apollo spacecraft. An elevator takes visitors to the observation deck overlooking the facility.

PALOMAR OBSERVATORY

PALOMAR MOUNTAIN, CA 92060. Tel: (213) 356-4033.
Hours: Sun–Sat 9 am–5 pm, closed Christmas.
Admission: Free.
Publications: Free brochure.
Reproductions: None.
Research: None.

A facility of the California Institute of Technology, Palomar Observatory is located on Palomar Mountain near San Diego. Its most well-known astronomical instrument is the famous 200-inch Hale telescope, the largest in the United States and one of the largest in the world. The observatory is used by professional astronomers, graduate students, and postdoctoral investigators who utilize the observatory's various instruments to study the position, distance, temperature, and chemical composition of stars, nebulae, galaxies, quasars, and other celestial objects.

To accomplish these studies, the observatory has, in addition to the Hale telescope, two Schmidt telescopes and a 60-inch telescope.

The 200-inch Hale telescope was a long time in realization. It took 11 years to polish the 15-ton glass mirror before the 530-ton telescope was dedicated in 1948. The Hale telescope is housed within a 12-story-tall dome. It is so precisely balanced that it can be moved by a $^1/_{12}$ horsepower electric motor. With it astronomers can study objects ranging out to 15 billion lightyears.

The observatory also has two Schmidt telescopes, one with an 18-inch aperture and the other with a 48-inch aperture. They are used to take extremely sharp photographs of large areas of the night sky. The 48-inch instrument photographed the entire sky that can be seen in the northern hemisphere.

The 60-inch telescope is used for much the same purposes as the Hale telescope except that the objects observed are not as faint. It also can be used to take large-scale direct pictures of the sky.

ROSWELL MUSEUM

NORTH MAIN AND 11TH STREETS, ROSWELL, NM 88201.
Tel: (505) 622-4700.
Hours: Daily 9 am–5 pm, Sun and holidays 1–5 pm, closed Christmas and New Year's.
Admission: Free.
Publications: Free brochure.
Reproductions: Posters, prints and postcards of exhibitions in the museum and related subjects.
Research: Small library open to members and professional people; appointment is helpful.

The Robert H. Goddard Rocket and Space Wing of the Roswell Museum in Roswell, NM, opened in 1969, and is a replica of the original workshop of America's pioneer rocket scientist, who launched the world's first liquid propellant rocket in 1926.

The workshop contains original machinery used by Goddard and his assistants (two of whom helped design the museum) or duplicate equipment purchased for the purpose. Additionally, as many original engineering drawings and original furnishings as could be located are on display. Also shown is a motion picture made of one of Goddard's earliest rocket launchers, the first such flight so recorded in the nation.

Of interest to visitors who have been to the Kennedy Space Center, as well as aerospace engineers and technicians in general, is one of Goddard's original rocket launching towers. In it is an exact duplicate of the last liquid-propellant rocket he built in 1941–1942. Other objects on display include rocket engines, propellant pumps, various components and many photographs of Goddard and his numerous rockets.

U.S. AIR FORCE MUSEUM

WRIGHT-PATTERSON AIR FORCE BASE, DAYTON, OH 45433.
Tel: (513) 255-3284.
Hours: Mon–Fri 9 am–5 pm, Sat and Sun 10 am–6 pm, closed Christmas.
Admission: Free.
Publications: Free brochure.
Reproductions: Posters, prints, postcards and other reproductions of Air Force subjects.
Research: Library open to public 9 am–4 pm. It has files on aircraft, personnel and technical information.

The oldest and largest military aerospace museum in the world, the U.S. Air Force Museum presents a history of the technological development of America's military aircraft and spacecraft from the first airplane purchased by the U.S. Army Signal Corps in 1909 to the latest intercontinental ballistic missiles and space launch vehicles. Today, there are over 140 aircraft and

The USAF museum buildings are designed to guide of military aviation, visitors through the story rather than simply display a collection of aircraft.

missiles as well as many other aeronautical and astronautical artifacts on display, including—yes—a rock brought back from the Moon by Apollo astronauts. While the museum is designed so that visitors can move through the exhibits without guides, school and limited adult group tours can be arranged by appointment on weekday mornings. They are conducted by members of the Wright-Patterson Air Force Base Officers' Wives Club.

Among the non-aircraft displays are military uniforms dating from 1916 and personal mementoes of early military pilots such as diaries, letters, and awards and decorations. Within this section of the museum, is a display featuring the U.S. Army Air Force Band, of World War II, that was conducted by Major Glenn Miller. Associated with this feature are periodic concerts, tributes to the Major Glenn Miller Air Force Band. The concerts are held on the museum grounds and are open to the public.

Of special interest to visitors who build model airplanes is the exquisite Eugene W. Kettering Model Collection of some 600 airplanes at a scale of $^{1}/_{72}$ of both civil and military craft from the mid-1920's.

Other special exhibits include pictorial displays of the forerunners of aviation such as ancient Chinese kites, scenes from Greek and Chinese mythology, Leonardo da Vinci's concepts and lighter-than-air balloons, both civil and military. A poignant exhibit contains hand-made articles, drawings and paintings, clothing, diaries, photographs and items devised to assist in escape, all made by prisoners of war in World War I and II, Korea and Vietnam. More ominous is the display of the Little Boy and Fat Man atomic

bombs dropped on Hiroshima and Nagasaki in World War II and the Mark XVII thermonuclear bomb carried by the B-36 bomber after the war.

Foremost in the collection of historic aircraft and missiles is a replica of the 1909 Wright Military Flyer, built by the famous Wright brothers of Dayton. It is an exact copy of the original plane in the National Air and Space Museum, in Washington, D.C. However, it has an original Wright engine, propellers, chain and drive sprocket. Additionally, the cloth that originally covered one wing of the plane during its first flight in 1903 is on display. The original Wright 1911 modified B flyer, the first plane produced and sold in quantity by the brothers, is also on display. An interesting footnote to the history of aviation technology is an original Wright Flyer bicycle built by the brothers before they turned their talents to aircraft.

Significant airplanes from World War I include the SPAD VII, the plane used by famed American Lafayette Escadrille in France. The same type aircraft was flown by America's ace, Captain Eddie Rickenbacker. Also displayed is a Sopwith F-1 "Camel," perhaps best-known to child visitors because of the comic strip character Snoopy. It is a reproduction, built by Museum personnel from original factory drawings.

Another Dayton-based development, and one that looked forward to the infamous V-1 missile of World War II, is the Kettering Bug. It was developed by the Dayton-Wright Airplane Co. for the U.S. Army Signal Corps in 1918. The pilotless aircraft took off from a track and contained 180 pounds of high explosive. Guided to its target by pneumatic and electric controls, its wings fell off and it plummeted to its target.

An airplane significant in the history of aviation in the 1920s is the Douglas World Cruiser "New Orleans," one of three which become the first aircraft to fly around the world in 1924. Equally significant is a Martin B-10 bomber of the early 1930s, the first modern bomber built entirely of metal and with retractable landing gear, internal bomb storage and rotating gun turrets. B-10's were used against the Japanese in World War II by China and the Netherlands.

Well-known American World War II aircraft include the Douglas C-39 and Curtiss C-46 cargo planes; Piper L-4 and Stinson L-5 liaison and observation planes; North American B-25 "Mitchell," Boeing B-17 and B-29 "Superfortress," Douglas A-20 and B-24 bombers; and Curtiss P-40, Republic P74 "Thunderbolt," and North American P-51 "Mustang" fighters. Aircraft of other combatants in that war, both allied and enemy, are also shown. These include the English Supermarine "Spitfire" fighter, also used by the U.S. Army Air Corps, and the Westland "Lysander III" utility aircraft. The Japanese air force is represented by a Kawanishi N1K2 Shiden-kai "George 21" fighter, one of the best combat airplanes of the war. Also displayed is a Kugisho "Ohka" or Baka suicide bomb. The rocket-powered, manned bomb was also known as the Kamikaze. German aircraft of World War II are represented by the two rocket-propelled fighters Messerschmitt Me 262 and Me 163 and one of the best fighter aircraft in the European war, the Focke-Wulf FW-190. Also on display is a replica of the famous V-1 "Doodlebug" or flying bomb that fell in numbers on London and targets in Belgium.

The museum has also assembled a collection of vehicles that demonstrate the advance of aeronautical technology during the post-World War II years, the Korean War and the Vietnam War. Among the more significant of these craft on display is the Bell P-59 "Airacomet," which was developed in World War II but never flew in combat. However, as America's first jet-propelled fighter, it provided training for U.S. Air Force personnel and data for future designs. Also shown is the Lockheed F-80 "Shooting Star," which was developed too late for World War II but saw extensive service in the Korean War as a fighter-bomber.

Other historic, early jet fighters include the Republic F-84 "Thunderjet," North American F-86 "Sabre," Lockheed F-94 "Starfire" and various aircraft of the so-called "Century series" of fighters such as the North American F-100 "Supersabre."

To round out the history of jet-propelled aircraft, the museum displays a number of early American jet bombers such as the Convair B-36, North American B-45 "Tornado," Boeing B-47 "Stratojet," B-52 "Stratofortress" and Convair B-58 "Hustler."

A unique exhibit from the post-Korean War period is a Soviet Mikoyan-Gurevich Mig-15 "Fagot" fighter. Another unusual exhibit is the McDonnell XF-85 "Goblin", a project of the late 1940s. Only 24 feet long and weighing only 4500 pounds, the tiny, piloted jet plane was designed to fit *inside* a B-36 bomber and be launched from a trapeze to protect the bomber when attacked by enemy fighters. Equally interesting from the viewpoint of the history of aviation is the Ryan X-13 "Vertijet," a technological forerunner of the famous Harrier vertical-takeoff-and-landing jet fighter, first used in combat during the Falklands War of 1982. The X-13 made its first flight in 1956.

Other significant X (for experimental) craft on display include the Douglas X-3 "Stilleto," which was a test vehicle for future supersonic aircraft; the Bell X-5, the world's first plane to vary the sweepback of its wing in flight, and the famous North American X-15, in which several pilots earned their astronaut wings.

Two high-performance aircraft on display are the Lockheed U-2 spy plane and its successor the Lockheed YF-12, developed as a Mach 3 bomber interceptor, and an early version of the Lockheed SR-71 high-altitude reconnaissance plane.

Additionally, there are several guided missiles of note. These include the Jupiter, originally built for the U.S. Army, and the Atlas intercontinental ballistic missile, still used as a launch vehicle for spacecraft. A version of it launched John Glenn, America's first astronaut, into orbit, in 1962. Also exhibited is the Titan 1 intercontinental ballistic missile, a modification of which launched America's Gemini astronauts into space. The museum also has several spacecraft on view: the Mercury, the Gemini and the Apollo 15 command module which took astronauts to the Moon and returned them safely to Earth in 1971. Looking forward to the development of the Space Shuttle, the Museum also has on display the Martin X-24A and X-24B. These small, rocket-propelled, manned craft provided flight data used in designing the Space Shuttle.

U.S. NAVAL AVIATION MUSEUM

U.S. NAVAL AIR STATION, PENSACOLA, FL 32508. Tel: (904) 452-3606.
Hours: Daily 9 am–5 pm, closed Thanksgiving, Christmas and New Year's.
Admission: Free.
Publications: Free brochure.
Reproductions: Posters and postcards of naval and air subjects.
Research: None.

Located at the U.S. Naval Air Station, long-known as the Annapolis of the Air, the museum collects aircraft and other memorabilia representative of the development and growth of U.S. Naval aviation and its contributions to American space exploration.

The station's involvement in naval aviation dates from 1914 when two ships steamed into Pensacola harbor and off-loaded all U.S. Navy aircraft and personnel. Speculation at the time was that the naval air service would gradually disappear while languishing at the remote navy yard in Florida.

However, as the Museum now vividly demonstrates, naval aviation did not wither away but expanded in the subsequent decades. Indeed, the U.S. Navy made many important contributions to the advancement of aeronautics. The collection includes more than 100 aircraft, photographic displays, scale models, components, artifacts and personal memorabilia of naval and marine aviation pioneers.

One of the Navy's earliest contributions to aeronautics was the Curtiss NC-4 flying boat. Cruising at 75 miles per hour with a crew of six, it made the first transatlantic flight from the naval air station at Rockaway, NY to Lisbon on May 29, 1919. It is one of the three original aircraft involved in the flight.

The Navy's *first* airplane, the Curtiss A-1 "Triad," built in 1911 and named for its ability to fly in air, to land on ground or to touch down on the sea, is displayed in simulated flight suspended in the lobby where noted artists have placed the story of naval aviation on canvas.

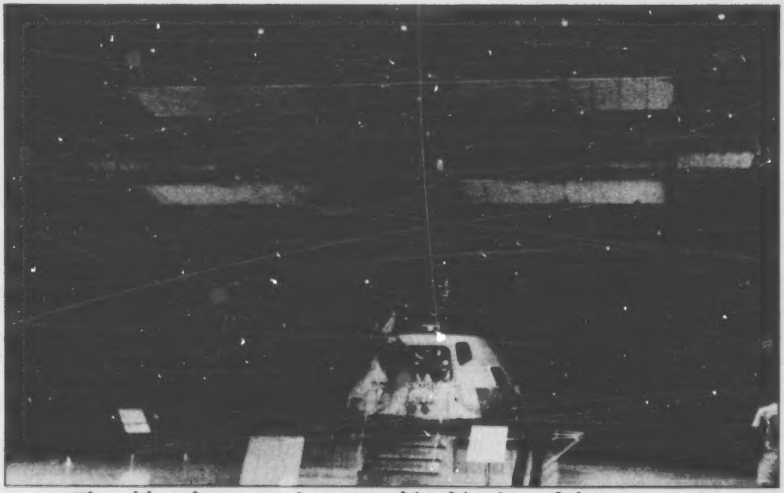
Another historic aircraft, the Curtiss N-9H, is also on view. It was the first seaplane to perform a loop, piloted by Marine Capt. Francis T. Evans in 1917. Evans was awarded the Distinguished Flying Cross for his expertise. Also shown is a 1918 MF flying boat, the first built by the Naval Aircraft Factory.

Extensive photographs on carrier development from 1922 to 1940 plus unique models of the USS *Kearsage* and TBMs, SB-2Cs, F4Us and F7Fs relive this aspect of naval history.

Selected displays and artifacts testify to the crucial period for naval aviation during 1941-45, when the Navy proved itself in the air over the Pacific and Atlantic oceans.

A Vought OS2U-3 "Kingfisher," the same type of naval aircraft that rescued Captain Eddie Rickenbacker after he floated for days on a life raft, is exhibited. The "Kingfisher" came to the museum via the Uruguayan Navy.

Other naval aircraft of historical significance are the Grumman TBM "Avenger" that had its operational debut in the Battle of Midway; the Douglas SBD-3 "Dauntless," a dive bomber that sank more Japanese ships than any other airplane in World War II; the Grumman F8F-2 "Bearcat," one of the best carrier interceptor-fighters of the post-World War II era; and a



The old and new are juxtaposed in this view of the museum's main hall. Hanging from the ceiling is the Curtiss A-1 "Triad", a replica of the Navy's first aircraft. Below sits the command module "Skylab".

rare Martin Am-1 "Mauler" capable of carrying a 9,000-pound payload.

Also on display is a PB2Y-5R "Coronado," one of which carried Admiral Chester W. Nimitz and party into Tokyo Bay for the formal surrender of Japan aboard the USS *Missouri* in 1945. The "Coronado" was sold to billionaire Howard Hughes when it was declared surplus after the war, but the Summa Corporation gave the mint-condition flying boat to the museum in 1973. Also of World War II fame is the "Hellcat," the plane that accounted for 75 percent of 5,156 enemy aircraft kills in air-to-air battles.

From the Korean War and Vietnam War there are craft such as the Douglas "Skyraider." Additionally, the visitors can see the Chance Vought F8U-1 "Crusader," first jet fighter in the world to have variable incident wings; the Grumman F9F-2 "Panther," first Navy jet fighter to take part in air combat over Korea, taking off from the USS *Valley Forge* carrier.

Three record-breaking airplanes of note in the history of aeronautics are also available. These are the Grumman F82-2 "Bearcat" in which Lieutenant Commander M. W. Davenport set a record in 1946. He took off in a distance of only 115 feet and climbed to an altitude of 40,000 feet in only 94 seconds. Another such plane is the Lockheed P2V-1 "Truculent Turtle" which broke the world's record endurance without refueling in 1946 when it flew from Perth, Australia, to Columbus, Ohio, a distance of 11,235 miles in only 55 hours and 17 minutes. Equally interesting is the Douglas D558-1 "Skystreak" that set world speed records of 640 and 650 miles per hour more than thirty years ago with navy and marine pilots.

An interesting footnote to the history of aviation in the Vietnam War is provided by the Cessna "Bird Dog" that landed aboard the carrier USS

Midway during the evacuation of South Vietnam. It was piloted by a South Vietnamese air force major who had as passengers his wife and five children. The plane landed safely even though it did not have the tailhook required for operational aircraft from carriers.

A spectrum of naval jet aircraft is represented by planes such as the T2J-2 "Buckeye," Grumman TF-9J "Cougar," Lockheed T-33B; Douglas A4-D "Skyhawk," Grumman F-11F-1 "Tiger" and Grumman F9F-2 "Panther."

Of particular value to those visitors interested in the history of science and technology is the museum's collection of more than fifty internal combustion and jet engines arranged in chronological sequence to illustrate the development of naval aircraft propulsion from the beginning of heavier-than-air craft to the planes of the jet age.

The U.S. Navy's role in space exploration is illustrated by the museum's central exhibit, the Skylab 1 command module spacecraft in which the initial crew of the Skylab space station was launched in 1973. This historic vehicle carried Captains Charles Conrad, Paul Weitz and Joseph Kerwin, all U.S. Navy officers, to the damaged Skylab for their 28-day mission. From it, they surveyed the stricken space station and planned their "damage control" procedures. Also displayed are personal memorabilia of Captain Robert Crippen, pilot of the Space Shuttle "Columbia" on its first space flight in 1981.

Future exhibits planned for the museum include the navy's development and operation of lighter-than-air vehicles, the role of the U.S. Coast Guard in the air, and the navy's expanding exploits in space.

UNIVERSITY OF TEXAS AT DALLAS

HISTORY OF AVIATION COLLECTION, BOX 643,
RICHARDSON, TX 75080. Tel: (214) 690-2996.
Hours: Mon–Fri 9 am–12, 1–5 pm.
Admission: Free.
Publications: Free brochures describing collection.
Reproductions: None.
Research: Library open to public. Covers aviation and space history, with a good lighter-than-air flight collection.

Widely recognized as one of the world's major aeronautical-history research libraries, the History of Aviation Collection of the University of Texas at Dallas contains more than 2 million items covering every facet of aviation. Located at the University of Texas campus at Richardson, the collection was formally dedicated in 1979 after fifty years spent gathering material including more than 200 substantial collections. The original nucleus of the collection was provided by George E. Haddaway, founder of *Flight* magazine, who started his own aviation library while a student at the University of Texas from 1926 to 1930.

First established in 1963 at Austin, the museum moved to Richardson when it acquired the Admiral Charles E. Rosendahl collection of lighter-than-air history, numbering more than one million items. Rosendahl's historical collection of lighter-than-air aviation is among the most compre-

hensive in America, including countless books, documents, correspondence, technical data and memorabilia plus historical hardware. Rosendahl was the senior surviving officer of the *USS Shenandoah* dirigible crash in 1925, director of rescue operations when the German airship Hindenburg burned in 1937 at Lakehurst, NJ, and commanded the *USS Los Angeles* and the *USS Akron* airships.

Another unique part of the collection is that of Erik Hildesheim, an early Danish aviator, credited with the Heim bearing still widely used in aviation and industry today. He was also an early researcher in the development of the helicopter. The Hildesheim collection is rich in early European lighter-than-air history dating from the 1700's and in early heavier-than-air history as well.

The Richardson facility also holds the original published works of Sir George Cayley, father of the modern airplane, and first editions of books documenting the Montgolfier balloon flights in 1783 and Lilienthal's glider flights. The papers of such aviation greats as Octave Chanute, the Wright brothers, Santos Dumont, Admiral Byrd, Lindbergh, Doolittle, Earhart and Yeager are also included, and the collection extends into the space age. In all, more than 200 pioneers of aviation have contributed to the library's valuable holdings.

Interesting and historically significant artifacts are displayed at the center, including photographic panels of the history of commercial aviation, models of early military aircraft, personal mementoes of early pilots and the German "Glasflugel" BS-1 glider, a record-breaking sailplane.

In addition to many books, periodicals and historical documents on the early days of American aviation, the collection has rare memorabilia and models.

CHAPTER TWO

NATURAL HISTORY

by
DOUGLAS J. PRESTON

THE ACADEMY OF NATURAL SCIENCES

19TH AND THE PARKWAY, LOGAN SQUARE,
PHILADELPHIA, PA 19103. Tel: (215) 299-1000.

Hours: Sun–Sat 10 am–4 pm, closed Thanksgiving, Christmas, and New Year's.

Admission: $2.75 adults, $2.50 students 13–18, senior citizens and military, free to members and children under 3.

Publications:
The Proceedings of the Academy of Natural Sciences, a collection of scholarly papers, is published annually. A general guide to some of the collection is: Jan Schmitz, *Treasures of the Academy*. 1982, $3.

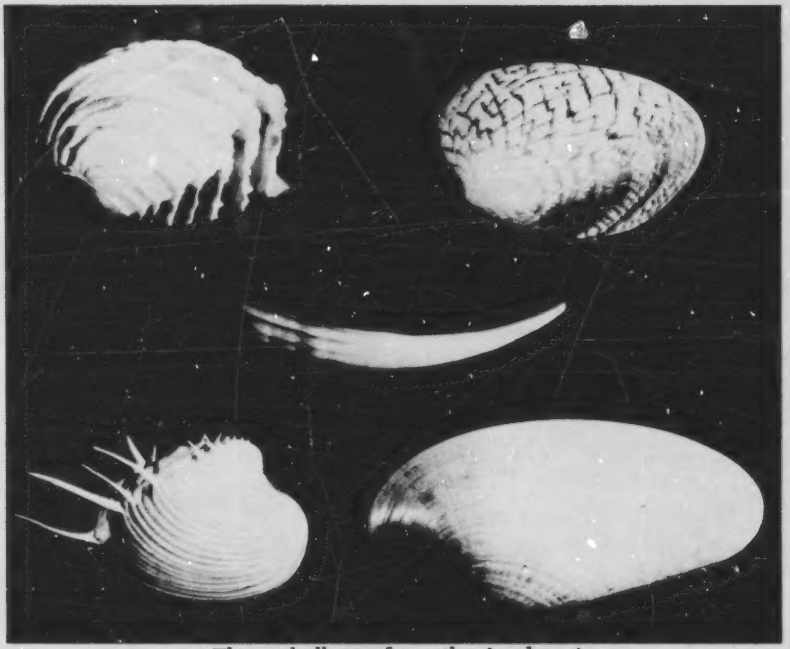
Reproductions: Some posters and postcards of objects in the collection and special exhibitions.

Research: Reference library open to public. Extensive historical collection, including almost all taxonomic literature 1812–1910, and 700 natural history books written before 1750. Many very rare volumes in all fields covered by the collection.

The venerable Academy of Natural Sciences was close to half a century old when Charles Darwin was elected a member. Darwin joined a group which included Thomas Jefferson, Titian Ramsay Peale, Joseph Leidy, John James Audubon, and the nephew of Napoleon, Charles Lucien Bonaparte. It is the oldest natural science establishment in the New World.

In 1812 a group of six men met at Speakman's Apothecary to discuss the formation of a society dedicated to the natural sciences. Although some conservative Philadelphians roundly denounced the society as "Godless" and "radical," the group formed the Academy and installed its headquarters on the second floor of a shop at 121 Chestnut Street. The peripatetic Academy moved five times until it finally arrived at its present location in 1872.

The Academy's collections, although topnotch from a scientific point of view, are perhaps even more interesting from the historical perspective. Many of the objects on display have a history as distinguished as many Philadelphians themselves. For example, on display is the fossil tooth of a prehistoric shark; by looking closely, the astute visitor can make out the name of its collector—"Thos. Jefferson"—written along its razor-sharp edge.



These shells are from the Academy's collection of over 10 million, the second largest collection in the world.

Jefferson, it turns out, was an avid naturalist, his particular interest being the prehistoric life of America. When Lewis and Clark set out on their 1804 expedition, Jefferson charged them with making a complete collection of natural history material; they accordingly brought back hundreds of specimens of insects, plants, minerals, shells, fishes, and fossils—many hitherto unknown to science (and most of which ended up in the Academy's cabinets.) When Jefferson gave his personal collection to the Academy, it included mastodon bones from Kentucky, also found by Lewis and Clark, and a whole suite of fossils discovered on Jefferson-commissioned expeditions to the south and west.

The Academy holds a number of historical firsts in relation to fossils. In 1858, the first dinosaur dug up in American soil was uncovered in a New Jersey pasture by an Academy member, William Parker Foulke. The bones were studied by the early paleontologist, Joseph Leidy, also an Academy member.

The Academy's bird collection is the oldest in the United States, consisting of some 170,000 specimens and 8,500 sets of eggs (including one on display from the Great Auk, extinct since 1847.) John James Audubon gave the Academy many of the birds he had collected as models for his *Birds of*

America; some of these are exhibited in the Academy's Hall of Endangered Species. (One bird that no longer belongs in the hall is the extinct passenger pigeon, which Audubon once described as so numerous they "darkened the skies" of the middle west.) Just recently the Academy has expanded its work on birds by establishing project VIREO, which hopes to add hundreds of thousands of photographs of birds to their specimen collection so that scientists can study habitats, coloration, and behavior.

Another old collection is the herbarium, with many of its two million specimens dating back before 1800, making it one of the finest herbaria in the world. Over 500,000 of these were plucked from Pennsylvania and New Jersey soil. They form an invaluable record for ecologists trying to determine man-made changes in the flora of the area since 1800. The herbarium also includes Captain Cook's plants from his various expeditions up to 1841.

An important ichthyology collection came from Charles Lucien Bonaparte, who was an avid naturalist. Bonaparte published the massive and ambitious *Fauna Italica,* a compendium of the fishes, birds, mammals, and reptiles of the Mediterranean. The Academy received all of Bonaparte's fishes, which made it the acknowledged leader in Italian ichthyology in the U.S. (For what it's worth, the Academy also has the most complete collection of X-ray images of eels in the world.)

Shell collectors everywhere know of the Academy's malacology collection, which at 10 million is second only to the Smithsonian's. On display are beautiful specimens of *Murex pecter, Turbo marmoratus, Cyroraea tigris, Conus gloriamaris* and *Spondylus butleri,* among others.

The first United States Exploring Expedition added a great deal of rare and important material to the Academy's collections and exhibits. Between 1838 and 1842, a fleet of vessels circumnavigated the globe, ostensibly to chart sea routes for American whaling and merchant ships. Four scientists from the Academy were invited, and the expedition mapped the shorelines of Africa, Southeast Asia, South America, Hawaii, Fiji, New Zealand, Samoa, the Marshall Islands, Tahiti, northern California, and 1,600 miles of Antarctica.

Before leaving the Academy, visitors must look up the great amethyst boulder on display. This single, gem-quality crystal is about the size of a basketball, and is an extremely deep, rich purple. Nearby is another wonderfully purple specimen, a 57-pound tourmaline discovered in 1978. Many minerals in the hall are part of the Adam Seybert mineral "cabinet," the first important mineral collection in the U.S., which was one of the first acquisitions of the Academy in 1812.

Although the Academy has a paucity of large dinosaurs, the one specimen on display is impressive indeed. It is a mounted corythosaurus, a kind of duck-billed dinosaur, whose bony crest on top of the skull reminded the discover of the helmets worn by Corinthian soldiers of ancient Greece.

If you visit the Academy with children, don't forget to show them the Egyptian mummies, the African Cave, the jaguar diorama, the lions, and the children's nature museum called "Outside-In." But it might be better not to emphasize the manly exploits of Davey Crockett and Daniel Boone—both, it

seems, were flower pickers, and somewhere in the Academy are their not insignificant collections of pressed plants and flowers.

AMERICAN MUSEUM OF NATURAL HISTORY

CENTRAL PARK WEST AT 79TH STREET, NEW YORK, NY 10024.
Tel: (212) 873-1300.

Hours: Mon, Tues, Thurs, Sun, 10 am–5:45 pm, Wed, Fri, Sat 10 am–9 pm, closed Thanksgiving and Christmas.

Admission: Suggested contribution $3 adults, $1.50 children; free to all Fri–Sat 5–9 pm.

Publications:

John Perkins, *To the Ends of the Earth: Four Expeditions to the Arctic, the Congo, the Gobi, and Siberia*. 1981, np.

Reproductions: Some posters, prints and postcards of objects in the collection. Photographic prints available on fee basis, showing early twentieth-century installation of Tyrannosaurus, transportation of meteorites, other subjects.

Research: Library open to public; Collections in all areas open to research scientists and graduate students by advance appointment only.

The American Museum of Natural History is listed in the Guiness Book of World Records as the largest museum in the world. Whether this is true or not, the American Museum defies reasonable description and enumeration. Its reddish Romanesque Revival towers rise above Central Park on the West Side of Manhattan; hidden behind its dignified façade lie an irregular grouping of 21 interconnected buildings and a Planetarium—the museum, *in toto*, is physically larger than the Empire State Building.

The American Museum does not have the largest collections in the country, but it has arguably the best: its 35 million specimens range from the world's largest recovered meteorite (34 tons) to the world's smallest bee (1/1000 ounce), with a vast assortment of astonishing things in-between—the Star of India, a herd of elephants, the largest crystal on display, the great *Tyrannosaurus rex* skeleton, a 94-foot great blue whale, a procession of fossil mastodons and mammoths, an actual mummified dinosaur, a Haida ceremonial canoe, towering totem poles, a section of a tree dating back 4,000 years, and much more. Although the Museum's exhibits cover about sixteen acres of floor space, over ninety percent of the collection is not on display. Much is carefully packed away in hundreds of vaults and storage rooms. Some 200 or so staff scientists study the collections for a variety of research projects, ranging from cockroach behavior to witchcraft, to the origin of the solar system. To support this research and increase its collections, the Museum has sponsored over 1,000 expeditions to remote areas of the world, including Roy Chapman Andrews' nine-year exploration of Outer Mongolia and Robert E. Peary's discovery of the North Pole.

The American Museum was founded in 1869 by Albert S. Bickmore, a disgruntled student of the great Harvard zoologist, Louis Agassiz. Bickmore became disenchanted with Agassiz's high-handed behavior and decided to found a museum of natural history in New York, modelled after (and he hoped excelling) Agassiz's museum at Harvard. He managed to interest a

group of prominent New Yorkers in his scheme, and in 1869 the museum received a charter from the city.

The first permanent museum building was a gloomy neo-Gothic structure erected on what one observer called a "disconsolate tract of ground" next to Central Park. (Before construction could proceed a group of squatters with their squealing pigs had to be evicted from the grounds.) As the City of New York grew and rapidly became the financial center of the country, the museum found no lack of wealthy, influential angels, among them J.P. Morgan, Morris K. Jesup, and Teddy Roosevelt, Sr.

An interest in the huge and perfect is the museum's hallmark. Upon entering, you step right into a cavernous, echoing hall. Ahead, a herd of elephants, grouped in alarm with ears extended and trunks raised, looms out of the African mammal hall. To the left, you can see another group of elephants in the Asiatic mammal hall. As you proceed deeper into the museum, one hall opens into another in a seemingly endless procession of astonishing, beautiful, and strange objects and exquisite dioramas. Walking through the museum is like taking a journey in time and space. One can land in the Gobi Desert, and in the next moment be looking into a seventeenth-century bazaar in Samarkand or gazing at the grinning skull of *Tyrannosaurus rex*.

A sampling of the best halls would have to include the dinosaur and fossil mammal halls on the museum's fourth floor. These display the best collections of their kind in the world. Here are the great beasts for which the museum is justly famous. One of the most interesting of these is the "mummy dinosaur," which is actually the fossil of a mummified duck-billed dinosaur. This exceedingly rare specimen was discovered by an eccentric collector around the turn of the century in the West. You can still see the layers of skin and ropes of dessicated flesh clinging to the bones: the effect is so real that one expects it to stink. (It is, fortunately, entirely stone.) On this floor you can view the dinosaur eggs Roy Chapman Andrews discovered in Outer Mongolia in 1922, causing a sensation in paleontological circles. One of the eggs contains the fossil remains of a dinosaur embryo, a find which was the first conclusive proof of the eggs' origin.

Fossils give way to mammals, Indians, birds, primates, reptiles, and amphibians on the third floor; birds, mammals, the peoples of Asia, Africa, and Central America on the second floor; and so forth down to the basement. There are some 38 exhibition halls in the Museum, laid out in a labyrinthine fashion. (The museum gives away maps at all the entrances.)

Another peerless set of halls is the section of Meteorites, Minerals and Gems. Entering the mineral hall is like entering the bowels of the earth: the floor and walls are covered with dark brown pile carpeting, and the ceiling is painted black. The various gems and minerals are spotlighted, and leap sparkling out of the dimness. Some of the specimens are stunning: a two-*ton* slab of jade; a star sapphire the size of a golfball; a gigantic mass of gold crystals worth $250,000; a 135,500-carat* single crystal of topaz; and a 4½ ton block of deep blue, azurite malachite. Some of the many other fascinating pieces on display are a truly orange sapphire; the Patricia emerald,

thought to be the finest uncut emerald in the world; the Newmont Azurite, called by many the most valuable non-gem mineral in existence; and a nine-pound garnet crystal discovered while digging the New York City subway.

Next door is the Hall of Meteorites, dominated by the great Ahnighito Iron, the largest recovered meteorite in the world, which rests on six massive steel posts that are anchored in the bedrock underneath the museum. The Ahnighito and two other meteorites in the hall were discovered by Adm. Robert E. Peary in the 1890s during one of his attempts to reach the North Pole. The Eskimos had discovered the same meteorites centuries before and had been using them as a source of iron for their tools.

Don't try to see the whole museum in a day. Stick to a few halls during each visit, and be sure to pick up one of those free maps if you don't want to spend the night with the dinosaurs.

ANNISTON MUSEUM OF NATURAL HISTORY

4301 MCCLELLAN BOULEVARD, PO BOX 1587,
ANNISTON, AL 36201. Tel: (205) 237-6766.

Hours: Tues–Fri 9 am–5 pm, Sat 10 am–5 pm, Sun 1–5 pm.
Admission: $1.50 adults, $.75 children. Tours: $1 adults, $.50 children.
Publications: Brochures and newsletters describe the collection and are free at the museum.
Reproductions: Posters, postcards and prints of objects in the collection and surrounding nature trails.
Research: Reference library open to museum members and research staff.

A "Did You Know..." fact sheet distributed by the Anniston Museum of Natural History reports that the baobab tree in the African Hall is "the largest reconstruction of a baobab tree in the world." This magnificent and misshapen tree (all baobabs lack dignity) is entirely artificial. Next to the baobab (and dwarfed by it) is an African elephant in a state of alarm, with ears erect, facing its adversary (which in this case would be you and me.) The baobab and the elephant are one of many pleasant surprises in this fascinating, out-of-the-way museum.

Equalling the baobab in ungainliness is the museum's pteranodon, an exact replica of the 80 million-year-old flying reptile that spread its fifteen-foot wings over the American middle west, when that area was lapped by shallow seas.

The African Hall contains more than 100 creatures, including the rare black rhino, eland, giraffe, lions, leopards, monkeys, and gazelles, and a colony of termites, among others. The leopard diorama is especially good, showing the well-muscled cat crouching on a moss covered ledge, peering with beady eyes at something which has rustled the artificial leaves off to its right.

Some time ago the Museum came into the possession of William Werner's habitat bird collection of 600 specimens collected a century ago, which are among the earliest examples of the museum's "habitat group." (Previously, most museums had lined up stuffed specimens in dusty cases.) The Museum turned this collection into its Ornithology Hall in a very clever way. Instead

The African hall displays animals in reproductions of their natural habitat. An eland family group, foreground, grazes with the giraffe and black rhino. The elephant and baobab tree are in the background.

of trying to incorporate the old-fashioned and charming habitats into a slick 20th-century setting, the exhibit designer very wisely recreated a Victorian atmosphere in the hall. The happy result is not only a lovely bird collection, but an interesting glimpse at the nineteenth-century world of natural history.

New walk-in exhibits will add to the museum's fascination. You can crawl into a mole tunnel and see live moles living their lives underground, or you can get a realistic whiff of the scents that various animals use to mark their territory. The Anniston mole hole is part of an exhibit called *Space To Live In*, which explains such concepts as territory, home range and migration. Another walk-in display reproduces an Alabama cave with a 20-foot waterfall.

ARIZONA-SONORA DESERT MUSEUM

ROUTE 9, BOX 900, TUCSON, AZ 85740. Tel: (602) 883-1380.

Hours: Labor Day–June 1: Sun–Sat 8:30 am–sundown June 1–Labor Day: Sun–Sat 7 am–sundown.

Admission: $5 adults, $2.25 students 13–18, $.75 children 6–12, free to children under 6.

Publications:

William H. Carr, *Pebbles in Your Shoes*. 1983, $5.25.

Christopher L. Helms, *The Sonoran Desert*. 1980, 1983, $3.75.
Sonorensis. quarterly, free to members.
Reproductions: Six natural history posters by painter Nick Wilson.
Research: Library open to members. General collection on the flora and fauna of the Sonora Desert region.

The Arizona-Sonora Desert Museum—dry as its name may sound—is one of the most exciting museums in the Southwest. Although the museum focuses on the great Sonoran Desert of western North America, ingenious and creative exhibit planners have wisely interpreted this subject as broadly as possible. The result is a museum whose scope spans all five-billion years of earth history and that of the galaxy itself.

The new Earth Sciences Center is a case in point: using "hands-on" exhibits and the latest in museum exhibt technology, the Center tells the geological and biological story of the Sonoran Desert from the creation of the earth to the present. In the main gallery is the "Orb," a fifteen-inch translucent hemisphere which serves as a kind of movie screen for earth history. Projected from below the orb is an animated film, showing, in two minutes, the entire geologic history of planet earth. The film opens with the earth condensing from a cloud of gases and dust, and then goes on to detail

Beneath a transparency of a painting of the Milky Way and photographs of various nebulae in the galaxy, visitors trace the 5-billion-year history of the Sonoran Desert.

the development of the earth's crust and the ceaselessly shifting movement of the continents over millions of years. Odd continental shapes coalesce into the great pan-continent, Pangaea, which then splits and breaks up, with the continents gradually transforming until, suddenly, an unfamiliar earth becomes recognizable. The simulated revolution of the planet brings western North America to the top of the Orb, prominently displaying the Sonoran Desert. And finally the image dissolves to a photograph of the earth taken from the Moon, in which our planet looks small and impossibly fragile.

In the same hall is the beautiful "Aquarium of Stars," created by artist Jon Lomberg. This three-dimensioinal painting of the Milky Way galaxy reveals what it would look like to an observer thousands of light years outside the spiral arms, looking at the galaxy edge-on. The artist created the image by painting on nine layers of plexiglass, viewed in black light. Our tiny sun is represented by the end of an optical fiber (illuminated by a pushbutton) which reveals it to be in an unremarkable position near the edge of this vast pool of stars.

Throughout this gem of a museum, the primary subject of the Sonoran Desert has been broadened to include any number of fascinating topics. Even if you don't care a whit for the desert, you will be captivated by this unusual museum.

JAMES FORD BELL MUSEUM OF NATURAL HISTORY

17TH AND UNIVERSITY AVENUES SE, MINNEAPOLIS, MN 55455.
Tel: (612) 373-2423.
Hours: Tues–Sat 9 am–5 pm, Sun 1–5 pm, closed major holidays.
Admission: Free.
Publications: Occasional papers, booklets, pamphlets and technical reports of a scholarly nature.
Reproductions: Nature recordings, posters and postcards of the collection and environs.
Research: Library open to public for research purposes; university affiliates may borrow.

Most of the Bell Museum consists of dioramas and habitat groups featuring the flora and fauna of Minnesota, from its northern coniferous forests to its "Pipestone Prairie" and southeastern deciduous forests. The dioramas are beautifully constructed and represent some of the finest examples anywhere. Here we see a Minnesota wolf pack silently following the trail of a deer; wood ducks and warblers in a forest blooming with spring wildflowers; or a family of beavers building their lodge of gnawed sticks. But what is most remarkable about the dioramas is their background paintings. Most museum diorama backgrounds are painted by capable but unremarkable artists; not so for the Bell Museum, which had the good fortune of employing the noted wildlife artist Francis Lee Jaques. Jaques grew up in Kansas and northern Minnesota where he learned to love nature as it is—beautiful but harsh. When he began his career as a painter (he also worked

Grey wolf (timber wolf) diorama actually stops at the edge of the foreground rocks. The excellent background painting is by Francis Lee Jaques.

as a lumberjack, railroad fireman, and taxidermist), his aim was to "paint the thing as it looks, only more so."

On the third floor of the Museum is the Jaques Gallery, permanent home to many of the artist's oil paintings, watercolors, sketches and studies. The gallery also exhibits works of contemporary wildlife artists and natural history art. (The Museum owns many of the original woodblocks of the eighteenth-century English natural history artist, Thomas Bewick, and all the original art for T.S. Roberts's *The Birds of Minnesota*.)

The museum's scientific collections, incidentally, are especially strong in Pleistocene bison and musk ox fossils, and varieties of seeds.

A large "Touch and See" room for children at the rear of the Museum (covering almost 4,000 square feet) has a great assortment of natural history items culled from the collections, including skins, bones, antlers, and rocks. Staff members are available to help children figure them out.

CALIFORNIA ACADEMY OF SCIENCES

GOLDEN GATE PARK, SAN FRANCISCO, CA 94118.
Tel: (415) 221-5100.

Hours: July 4th–Labor Day: Sun–Sat 10 am–7:30 pm Labor Day–July 4th: Sun–Sat 10 am–5 pm.

Admission: $2 adults, $1 senior citizens, children 12–17, $.75 children 6–11, free to children under 6.

Publications: Scientific publications include:

Proceedings of the California Academy of Sciences.
Occasional Papers from the California Academy of Sciences.
Popular publications are:
Bruce Finson, *Guidebook: California Academy of Sciences*. 1981, $2.
Pacific Discovery Magazine. published quarterly, $7.50 per year.

Reproductions: Postcards of some of the exhibits.
Research: Reference library open to Academy members, visiting scientists and graduate students.

The California Academy of Sciences was founded by a group of San Francisco physicians and businessmen only four years after the California gold rush of '49, making it one of the oldest scientific institutions in the West.

The entrance to the Academy is dominated by two large exhibits—the geophysical globe and the great allosaurus skeleton. It isn't clear what the two exhibits have in common, but in a curious way they prepare the visitor for what's inside the Museum. The globe is a topographical three-dimensional model of what the earth would look like if someone pulled the plug on the oceans. The land topography is familiar, but the ocean topography—with its mid oceanic ridges, continental shelves, abyssal plains and deep ocean trenches—is strange and new. (One almost expects to see blank spots labeled "unknown territory," as on old maps.)

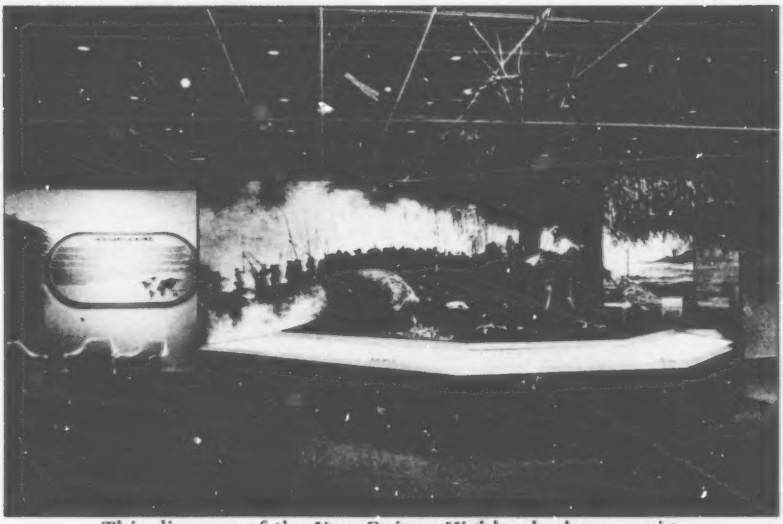
The allosaurus skeleton is posed in a threatening stance, jaws agape, with its back turned to the globe. At fifteen feet high and twenty-seven feet long, it is somewhat smaller than tyrannosaurus and brontosaurus but still impressive. (Appropriately, he was an habitué of western parts around 130 million years ago; his remains were found in Utah.)

To the left of the beast and globe is the Museum's African Hall, containing a number of superb habitat groups, which are like magical windows into the remote recesses of the African continent. Much of the material in the hall was collected by Leslie Simson, mining engineer and big game hunter, who donated his collection to the Museum back in the thirties.

One of the best dioramas shows the shy mountain gorilla in its fog-shrouded habitat—the high rain forest of the Zaire-Rwanda area. Only about 10,000 of these animals remain on the steep volcanic mountainsides at altitudes of 10,000 to 13,000 feet. In the diorama the gorilla is standing erect, framed by tree limbs draped with lichens and mosses.

The largest habitat group portrays an East African waterhole during the dry season, surrounded by animals which have come to drink and browse on the green foliage. The vast East African grasslands support the most diverse assemblage of mammals in the world; and many of these depend on a chain of waterholes such as this one. (Even carnivores such as lions and leopards frequent the waterhole, both because of the concentration of animals there and also because the brush and trees provide hiding places.) Here we see several giraffes, zebra, an impala, Grant's gazelles, the somewhat absurd-looking gnu, and a kongoni with its characteristic Z-shaped horns. The attention to detail gives the entire scene a vitality and realism not always present in museum habitat groups.

Around the corner from Africa is the Hall of Botany, and against one wall is the "crown jewel" of the hall and its most popular exhibit—a slice of a California redwood 31 feet in circumference. The tree was 1,710 years old when felled, and its bark is close to one foot thick in some places. (The thick bark of a redwood is actually a protective covering against fire and even



This diorama of the New Guinea Highlands shows a pig, left, and a man in ceremonial pig costume, right. Behind them are photographs of a skirmish and a village.

contains a fire resistant chemical.) The Academy's Hall of Man—completed in 1976—reflects our latest thinking about man, culture, and the environment. The hall explores the relationship between cultures and the environment, and how *Homo sapiens* has adapted to extremes in climate and geography. The exhibits focus on just a few very specific cultures, chosen for contrast: the Micronesians and their watery world; the Eskimo and their wintry world; the Australian Aborigines and their desert world; the Indians of the Andes and their high-altitude world; the New Guinean Highlanders and their rain-forest world, and so on.

The New Guinean Highlands exhibit portrays the Dugum Dani people who live in the hot tropical forest, and is especially interesting. The exhibit explores the important and complex relationship between pig-raising and the Dani social and ceremonial life, and the curious role warfare plays in that society. Warfare is mostly a form of social display, with the war parties dressing up in their finest and displaying their courage. Very few people are killed, and in fact the skirmishes seem to be designed to prevent serious bloodshed.

Dioramas and groups of figures incorporate the artifacts, dress, and technology of the culture, a far more interesting way of display than simply lining them up in glass cases.

The Academy also includes an excellent aquarium and planetarium, and a few odd exhibits: one about lamps (every kind you can imagine and some you never dreamed of), the fascinating little Insect Room, and the clock collection in the astronomy hall.

CARNEGIE MUSEUM OF NATURAL HISTORY

CARNEGIE INSTITUTE, 4400 FORBES AVENUE,
PITTSBURGH, PA 15213. Tel: (412) 622-3314.

Hours: Tues–Sat 10 am–5 pm, Sun 1–5 pm, closed Mon and major holidays.
Admission: Suggested contribution $1.50 adults, $.75 students and children, free to members; free Saturdays.
Publications: Various catalogues and brochures include:
Gallery Guide to Hillman Hall of Minerals and Gems. nd, $.75.
Guidebook to Carnegie Museum of Natural History. nd, $1.98.
Identification Guide to Pennsylvania Snakes. nd, $.75.
Reproductions: Prints, posters, postcards and slides of objects in the collection.
Research: Research library open to college students and natural history researchers by appointment.

One sunny morning in 1898, Andrew Carnegie opened the morning paper, the *New York Journal,* in his mansion in New York. A headline attracted his attention: *Most Colossal Animal Ever on Earth Just Found Out West!* Carnegie read on: "When it walked, the Earth trembled under its weight of 120,000 pounds. When it ate, it filled a stomach large enough to hold three elephants. When it was angry, its terrible roar could be heard ten miles." And so forth. Carnegie tore the article out of the paper and scribbled a note in the margin addressed to the director of Carnegie's new Museum of Natural History. The note read, simply, "Dear Chancellor, Buy this for Pittsburgh," and attached to it was a $10,000 check.

This was the beginning of the museum's interest in dinosaurs, which has resulted in a collection that ranks with the very best in the world. Although the Carnegie Museum of Natural History has fine, and even extraordinary, collections in other areas, it is most aptly termed the "home of the dinosaurs."

The museum's Dinosaur Hall displays the best and the brightest of the Carnegie collection in a parade of brown varnished skeletons spanning the 180-million-year reign of reptiles on the earth. The first of Carnegie's dinosaurs is here on display, the *Diplodocus carnegii* (nicknamed "Dippy").

Dippy was the indirect result of Carnegie's $10,000 check. Soon after the director of the Museum, W.J. Holland, received Carnegie's note, he travelled to Wyoming to meet the man who had discovered the "Most Colossal Animal," a fellow named Reed. Reed gave Holland a thigh bone from the alleged monster, and Holland was able to persuade Reed to sign a contract with the museum to help collect the rest of the skeleton. Holland managed to woo two paleontologists away from the American Museum of Natural History, J.L. Wortman and Arthur Coggeshall.

In 1899 the crew set up camp at the place of Reed's find. After digging for several days and not finding a single bone, Reed confessed that the thigh bone was the *only* bone he had found at the site. The "Most Colossal Animal," it seemed, was, at best, an outrageous exaggeration. But Wortman and Coggeshall continued to search for bones, and several months later discovered a dinosaur in a rock formation about thirty miles from the original site. Further excavation exposed two skeletons of diplodocus, which

were shipped to Pittsburgh and assembled into the composite "Dippy" now on display.

But most of the skeletons in this magnificent hall came from another dinosaur discovery, made in 1908 by Earl Douglass, a young paleontologist with the Museum. Douglass had heard from other scientists that a rock layer underlying much of the southwest outcropped in a scientifically unexplored area of northwestern Utah. Since the layer contained dinosaur bones elsewhere, Douglass reasoned that it might also contain bones at the Utah outcrop. After a summer of fruitless searching of the area, Douglass was about to give up when he found a few bits of bone in a dry wash. He followed the wash up to a ridge and, there in the rock, saw eight connected dinosaur tail vertebrae. Although he didn't know it at the time, Douglass had discovered the mother lode—one of the richest dinosaur graveyards ever found, one which would yield over 700,000 pounds of fossils for the Carnegie Museum alone. The area was later designated "Dinosaur National Monument." (See separate entry, page 000.)

Each skeleton from this quarry was hand-chiseled, bone-by-bone, from the extremely hard sandstone of the formation. Some of the prize specimens to come out of the ridge included a superb brontosaurus (now called apatasaurus) and an immature *Camasaurus lentus* which is one of the most complete sauropod skeletons known, displayed in the hall still embedded in its rocky matrix.

Mounted dinosaurs in the hall include the finest allosaurus ever found (a Jurassic meat-eater similar to Tyrannosaurus); a stegosaurus with its bony plates and spiny tail; a protoceratops dug up by Roy Chapman Andrews in the Gobi Desert (displayed with its famous eggs); and, of course, *Tyrannosaurus rex*.

These spectacular dinosaur fossils should not distract the visitor from the fascinating non-dinosaur fossils in the hall. A fossil mosasaur is on display, a long, vicious-looking marine reptile with razor-sharp teeth and a specially hinged jaw that enabled it to scissor up its prey and quickly swallow the gobbets. Several significant and rare fossils of pterosaurs (flying reptiles) are shown, including one crow-sized specimen named *Campylognathoides*, the only such specimen in the United States. Those interested in fish, turtles or ammonites (coiled, chambered fossil shells) will also have plenty to look at.

Adjacent to the Dinosaur Hall is the new Hillman Hall of Minerals and Gems which opened in 1980. This section, with its partially mirrored walls reflecting cases off to infinity and spotlighted masterpieces, is instructive as well as beautiful. Various parts of the hall illustrate our scientific knowledge about minerals, including radioactivity, mineral formation, classification, refraction, fluorescence, cleavage and fracture, color and luster, and so forth. But for sheer magnificence the "Masterpiece" area of the hall is unsurpassed. Here you will find a coiled and twisted silver nugget, an azurite with an impossibly deep-blue color, a bright yellow hemimorphite, a pink elbaite with a green top growing out of a cluster of quartz crystals, and a fine amethyst from Mexico. Also in the hall is a calcite crystal which in recent years has changed from a colorless hue to fire-engine red.

The Carnegie also has some splendid dioramas, of which the most popular (and terrifying) is the "Camel Driver Attacked by Lions." Obtained from the American Museum of Natural History in 1899, this life-sized diorama shows a male lion leaping upon a bellowing camel, with the Arab driver slashing out at the beast with a curved dagger. Near the fray is the dead female lion. Other halls worth exploring are the botany hall, the anthropology hall, and the transportation hall, which displays the Count of Toulouse's royal state coach (ca. 1740). Two rag-bag halls exhibit a wide assortment of things: the Hobby Hall, which illustrates leisure activities with artifacts ranging from antique watches to New Guinea Masks; and the Museum Potpourri, which displays a wild profusion of unrelated items awaiting installation in new galleries (an idea other museums might use).

Carnegie was a great philanthropist who gave to many causes, but he was wise enough to limit himself to one museum. He once wrote to the president of the American Museum of Natural History in response to a request for money:

> One thing I have found out—one Museum is enough, and I have one on my hands. I should be delighted to promise that when I get through with it I should consider the claims of another; but, between ourselves, I never expect to get there....

CRANBROOK INSTITUTE OF SCIENCE

500 LONE PINE ROAD, PO BOX 801, BLOOMFIELD HILLS, MI 48013.
Tel: (313) 645-3260.

Hours: Mon–Fri 10 am–5 pm, 7–10 pm, Sat 10 am–10 pm, Sun 1–5 pm.
Admission: $2.75 adults, $1.75 students 5–17 and senior citizens.
Publications: Scientific publications are available in:

The Cranbrook Institute of Science Bulletin. Monographs on natural history published irregularly.

Reproductions: Postcards and slides of objects in the collection.
Research: Reference library open to public. Primary collections in Anthropology, Botany and Zoology.

A publicity brochure says the Cranbrook Institute of Science is a "treasure for the mind and eye, a stimulant for the imagination, a pot of gold for a rainbowed curiosity" Purple prose notwithstanding, this is a reasonable description for this diverse museum in the Midwest, which includes a nature center, a planetarium, a lasera, a botanical garden and an observatory. One is tempted to throw "architecture" into the pot as an added attraction, since the Eero Saarinen-designed building is something worth seeing for itself.

The building contains a hybrid natural history and interactive science and technology museum. The mineral collection, laid out in classic natural history fashion, is a special delight; its 2,500 specimens of gems, minerals, and rocks is one of the best in the Midwest. The newest exhibition, the Hall of Light, is at the other end of the spectrum. Most of the exhibits here are interactive, using lasers, prisms, mirrors and other devices to trick the visitor out of erroneous ideas about the nature of light. The first exhibit is

clever: entitled "What is Light?" it consists of a hollow pillar with a hole cut in it. The inside appears to be dark, and the visitor is instructed to put his hand inside. Suddenly, the hand becomes brilliantly illuminated, showing that the pillar was filled with light all the time. The lesson: light, by itself, is completely invisible. Refraction is demonstrated by a laser beam shot through water and various lenses.

A sophisticated laser and prism system is part of the Institute's Lasera, which uses the powerful krypton laser to project abstract patterns and images on the dome of their Planetarium, to the accompaniment of rock music. For visitors preferring the real to the fantastical (and the silence of outer space to the clangor of rock music) an observatory is open to the public in the evenings, with its telescope trained on the heavens. (The celestial exhibits are changed periodically too, simply by pointing the scope in a different direction.)

Visitors can also play with a computer, watch bees in a glass hive, walk along nature trails, or join the Spring Maple Syrup Festival or the Fall Honey

A group of children at the Institute learn about the range of the modern world, which includes getting answers from a video screen as well as holding a model of a human skull.

Harvest. The Cranbrook Institute is a particularly fine example of the Midwestern sensibility. Without trying to offer the grand scale of its big-city counterparts, it nonetheless manages to open more of the natural world for its citizens than do many museums twice its size.

DINOSAUR NATIONAL MONUMENT

PO BOX 127, JENSEN, UT 84035. Tel: (801) 789-2115.

Hours: Labor Day–Memorial Day: Sun–Sat 8 am–5 pm, Memorial Day–Labor Day: Sun–Sat 8 am–7 pm; closed Christmas and New Year's.

Admission: $.75 general.

Publications: Books about the museum include:

Allen Hagood, Gweneth Reed denDooven, *Dinosaur Story Behind the Scenery.* 1972, $3.

Theodore E. White et al., *The Dinosaur Quarry.* 1961, $1.50.

Reproductions: Posters, postcards, films and slides of the exhibits and environs. There are also dinosaur models.

Research: Library open to public upon request; appointment is helpful.

Museum technician Adams removes sandstone from around the fossilized shoulder bone (coracoid) from a *Camarasaurus.* A rib is in the foreground and vertebrae are to the right.

The Dinosaur Visitor Center at the Dinosaur National Monument in Utah offers a view of the not-so-fearsome fossils that are never shown in those Japanese horror movies. Here you see them much as paleontologists find them, still partly buried in the ground that contains them. In some places you can watch as technicians use everything from jackhammers to delicate chisels to cut away the hard sandstone and expose the bones. And you can look through a window into a preparation laboratory to see how fossils are cleaned and preserved. This is the real thing: the end result of a 140-million-year-old natural burial ground on an ancient river course. The visitor can see the mortal remains of prehistoric crocodiles, turtles and 14 different species of dinosaur.

FIELD MUSEUM OF NATURAL HISTORY

ROOSEVELT ROAD AT LAKE SHORE DRIVE,
CHICAGO, IL 60605-2497. Tel: (312) 922-9410.

Hours: Sun–Sat 9 am–5 pm, closed Thanksgiving, Christmas, New Year's.

Admission: $2 adults, $1 children 6–17 and students, $.50 senior citizens, $4 families; free to members, children under 6, teachers, military personnel; free Thursdays.

Publications: Periodicals, books both scholarly and general, and brochures include:

Fieldiana.

4 sub-series: *Anthropology, Botany, Zoology, Geology* includes all scientific articles published by the Museum.

W.E. Curtis, *The Authentic Letters of Columbus*. 1895, $8.50.

J. Francis Macbride, *Natural Landscapes of the United States*. 1950, $4.25.

Henry W. Nichols, *Models of Blast Furnaces for Smelting Iron*. 1923, $2.

Karl P. Schmidt, *Crocodile Hunting in Central America*. 1952, $2.

Reproductions: Posters and postcards of some objects in the collection and special exhibitions.

Research: Reference library open to public, no museum admission required. It is strong in natural history, botany, paleontology, zoology and anthropology.

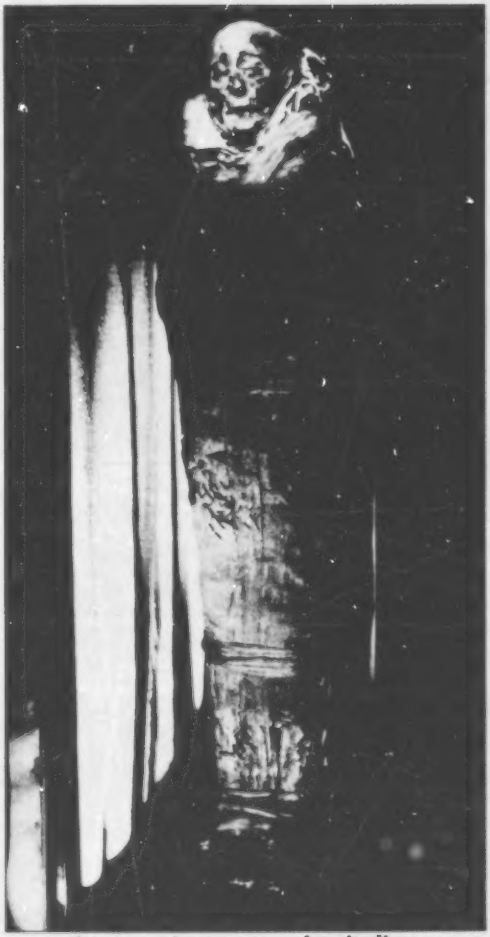
"I don't know anything about a museum and I don't care to know anything about a museum. I'm not going to give you a million dollars," was Marshall Field's testy reply to a request from Edward Ayer, who was trying to raise money to establish a museum with the collections of the 1893 World's Columbian Exposition. The Exposition was due to close in several months, and its collections dispersed, unless funding for a museum could be found. Ayer was having little success, especially as the business panic of '93 was in full swing. Field was the wealthiest man in Chicago, and whenever Ayer ran into him at various Chicago clubs he tried to touch him for a million, always receiving the same reply. Finally, four weeks before the closing of the fair, Ayer gave one last, desperate stab at Field, cornering him in his office. Ayer brought up the name of a man, A.T. Stewart, who had made millions selling dry goods just as Field had. "Now, Marshall Field," Ayer said, "you can sell dry goods until hell freezes over . . . and in 25 years you will be just the figure A.T. Stewart is now—absolutely forgotten." Two days later, at half-past nine o'clock in the morning, Ayer had his million dollars.

Today the Field Museum of Natural History in Chicago is one of the great natural history museums in the world. Only 0.5 percent of its vast collections are on display, but that 0.5 percent covers over eight acres of floor space in dozens of halls. The collections represent all forms of life on earth (non-human and human, past and present), as well as the composition of the earth and its nearest neighbors.

The Museum's main entrance opens into Stanley Field Hall (Stanley was Marshall's nephew), a vast and airy space seven stories high and the length of a football field. The hall has four displays, one for each scientific division in the museum: anthropology, zoology, geology (which includes paleontology) and botany. Anthropology is represented by a pair of towering Northwest Coast Indian totem poles, four stories high. Geology is magnificently symbolized by a mounted skeleton of the fearsome gorgosaurus, a carnivorous dinosaur, standing over the skeleton of its victim, a lambeosaur. (The gorgosaurus is the only such free-standing specimen in the U.S.) A pair of feisty bull elephants locked in battle are representatives of the zoology division. (The elephants were the work of taxidermist Carl Akeley, who began his distinguished career mounting Jumbo for P.T. Barnum.) And finally, a group of living trees symbolizes botany.

Downstairs is the Field's most popular exhibit, its Egyptian mummies, which are exceptionally comprehensive. Just added to the Hall of Ancient Egyptians are two Old Kingdom tomb chapels, which have been owned by the Museum since 1909 but never permanently displayed. The tombs were discovered in Saqqara near the step Pyramid of Djoser, where they were disassembled, crated up, and shipped to the States. Now they have been reconstructed, enabling visitors to actually enter the tombs. A large funerary ship made of cedar from Dashur is one of the other many outstanding objects in this hall, in which the artifacts are displayed, not as pieces of art, but in their cultural context, a refreshing change from the displays of most art museums.

The American Indian halls in the Museum are almost second to none. In one hall, a Pawnee woman's Ghost-Dance dress covered with arcane symbols recalls the desperate hope of native Americans, in the late 19th century, that their way of life would be restored. An Indian prophet had a vision in which a Christ-like figure predicted the disappearance of the white man and the return of the buffalo. The spirit taught the Indian a dance which would hasten the new era and make the dancer invincible. The Ghost-Dance religion spread like wildfire through the West, until the massacre at Wounded Knee Creek brought bitter disillusionment to its practicioners. The Pawnee dress, thought by art historians to be one of the most important native American artifacts in the country, was created during the brief Ghost-Dance period. In the same hall is a painted buffalo robe, which very probably belonged to Chief Joseph of the Nez Percé Indians of the Sahaptin family (although the exhibit label does not identify it as such). Paintings on buffalo hides acted as historical records or a recount of exploits for a warrior or tribe, and this particular robe depicts the famous last flight of the Nez Percé. Two other superb buffalo robes, both painted by Chey-



This Egyptian mummy has its linen wrapping pulled away from the head to expose its amazing state of preservation.

enne warriors, are also part of this really magnificent collection.

On the other side of the world (and one flight up) is the small but fascinating Hall of Chinese Jades, with pieces dating from 4,000 B.C. Dominating the hall is the great, green imperial jar, one of the largest jade artifacts in the world.

Although most objects are behind glass, the Museum recently opened the "Place for Wonder," where objects are meant to be handled, examined, touched, poked, or prodded. Some of the touchables include a woolly

mammoth tooth next to a modern elephant tooth; a bird whose feathers are meant to be ruffled (if it falls apart the museum has 300,000 more); children's clothing from China to be tried on; and "One-Ton Charlie," a stuffed polar bear.

Fields's million dollars, it seems, has gone a long way.

HARVARD UNIVERSITY MUSEUMS

MUSEUM OF COMPARATIVE ZOOLOGY, AGASSIZ MUSEUM

(617) 495-2463.

THE BOTANICAL MUSEUM

(617) 495-2326.

PEABODY MUSEUM OF ARCHEOLOGY AND ETHNOLOGY

(617) 495-2248

THE MINERALOGICAL AND GEOLOGICAL MUSEUMS

(617) 495-3045.

24 OXFORD STREET, CAMBRIDGE, MA 02138. Tel: (617) 495-1910.

Hours: Mon–Sat 9 am–4:30 pm, Sun 1–4:30 pm, closed Thanksgiving, Christmas, New Year's, July 4th.

Admission: Admission charged; free Mon.

Publications:

Elizabeth Hall, Max Hall, *About the Exhibits: Museum of Comparative Zoology*. 1964, 1975, np.

Plant Nature Guides. 4 booklets. nd, $3.25 each, $15 all four. (Exotic Plants, Flowers, Trees, Herbs and Spices)

Richard E. Schultes, William A. Davis, *The Glass Flowers at Harvard*. 1983, $15.49.

The *Bulletin* and *Breviora* are publications of scholarly papers on or related to the museum collections.

Reproductions: Some posters, prints and postcards of objects in the collections.

Research: Library open to public.

For two thousand years scholars repeated Aristotle's observation that a mayfly had four legs, until someone bothered to check and found it had six.

This kind of excessive reliance on written authority irked the great Swiss zoologist Louis Agassiz, who became a professor at Harvard University in 1847. Agassiz discouraged the use of books among his students, and he taught them to *look at* things with their own eyes. Thus, it is only natural that the museum Agassiz founded at Harvard in 1859 is a fabulous place for *looking at* the things of nature, in all their splendid and capricious manifestations.

The Museum of Comparative Zoology (often called the Agassiz Museum or

simply the "MCZ") is tucked away on the Harvard campus, and is part of a larger complex that includes the Botanical Museum, the Peabody Museum of Archaeology and Ethnology, and the Mineralogical and Geological Museums.

Although the Harvard museum is physically smaller than the American Museum of Natural History or the Field Museum of Natural History, its display pieces are drawn from equally large and excellent collections, which has resulted in a high proportion of wonderful specimens on display. The Museum also has the charming atmosphere of the old Victorian "cabinets" of natural history, which in a museum of lesser specimens might detract, but which actually enhances this museum. No flashy graphics or snappy label copy is necessary to wow the visitor, moreover, it's the kind of museum one *expects* to find at Harvard University.

We begin our tour of this museum with a curious pair of mounted pheasants in the "MCZ". In 1786, George Washington received a gift of these pheasants from the Marquis de Lafayette, who had received them from King Louis XVI from his private reserve. When the American naturalist, artist, and collector Charles Willson Peale heard about the gift he wrote straightaway to General Washington:

> "Having heard that you have been presented with some beautiful Birds of China I take the liberty of requesting in Case of the death of any of them, to have them packed in wool and put in any sort of packing Case, and sent by the Stages to me, and I will preserve them in the best manner I am able . . ."

Not much time had passed when Peale received this letter from Washington:

> "You will receive by the Stage the body of my Gold pheasant, packed in wool agreeable to your directions. He made his Exit yesterday . . . I am afraid the others will follow him but too soon . . ."

One other did follow soon, and the pair of them can be seen in a hallway between the fossil invertebrates and the fossil mammals.

Just around the corner is another curious specimen, about 120 million years older than the pheasants and a good deal larger. This is the mighty kronosaurus, the only fully mounted specimen in existence. This 42-foot marine reptile skeleton was discovered in 1932 during a Harvard expedition to Australia, which had been sent for the purpose of collecting "specimens of the kangaroo, the wombat, the Tasmanian devil and the Tasmanian wolf."

Although they were prepared for the strange fauna of Australia, no one had expected to find anything quite so strange as this. The kronosaurus was the largest of all the plesiosaurs, those large carnivorous reptiles that cruised the Cretaceous seas during the age of dinosaurs. One member of the Harvard expedition, William Schevill, a young graduate student of paleontology, stayed longer than the rest. He spent his time questioning ranchers in Queensland about the existence of any odd-looking rocks on their property. One rancher told Schevill that he knew of an outcrop with

These beautiful "Indian Pipes," also called corpse plant, are made of blown glass. Leopold and Randolph Blaschka worked fifty years to make the 4,000 models in the Harvard collection.

something strange sticking out of it, and showed him the site. Schevill, realizing that the hard limestone encased a rare fossil, blasted out some six tons of the rock and shipped it back to Harvard. Lack of funds delayed the painstaking removal of the fossil until 1939, when the nine-foot skull was chipped out and placed on exhibit. The rest of the creature sat in the gloom of the museum's basement for 15 years until Godfrey Cabot of Boston (whose ancestor Thomas Perkins had witnessed a 60-foot creature surface in Gloucester in 1817) gave the museum $10,000 to free the beast from its rocky mantle. The skull and body were finally reunited and put on display in 1958.

In addition to kronosaurus there are other astonishing fossils in the collection. Nearby is a fossil turtle shell of equally compelling proportions, which once rode on the back of a creature only slightly smaller than a Toyota automobile. Next to the pheasants (to backtrack a bit) is a genuine coelacanth, resting in a tank full of alcohol. Backtracking even further, in

the hall of fossil mammals is a mastodon from Hackettstown, New Jersey, discovered with four other mastodons by a farmer in 1844 who was digging up a swamp to fertilize his fields.

Down the hall is an impressive display of insects. Although not as big as kronosaurus, they are big enough—an atlas moth with a wing surface of 25 square inches; a hercules beetle that measures five inches from the tip of its evil-looking horn to the end of its fuzzy abdomen; and a four-inch brown beetle that may have been collected by the philosopher William James.

A narwhal (an arctic cetacean), gorilla, gigantic crocodile, the oldest egg, a paper octopus, and a model of the 450-million-year-old sea floor near Cincinnati are just a few other things worth viewing.

We have yet to take leave of Harvard. To the right of the MCZ (in the same complex of buildings) is the extraordinary Botanical Museum. Here visitors can view a great many specimens in this "Museum of Vegetable Products" (as it was first called in 1858)—all made of delicate, blown glass.

Most people are familiar with the fake, plastic or silk flowers one sees in hotel lobbies. This will not prepare you for the beauty and utter *realism* of the glass flowers at Harvard. From fall maple leaves in brilliant rust to peach flowers to strawberries to Venus's-flytraps to papery-thin poppy flowers—they are all here.

The flowers were started by a father and son team of German glass artisans, Leopold and Rudolph Blaschka and were continued by Rudolph after his father's death. The flowers are the result of a half-century of work. The Blaschkas had been employed making delicate glass models of marine invertebrates for various museums (including Harvard's MCZ), when the first director of the Botanical Museum, professor George Goodale, decided that a museum of dried plants and flowers simply wouldn't suffice. Goodale wanted something that would capture the fleeting beauty and delicacy of plants, and when one day he saw the Blaschkas' replicas of marine invertebrates in the MCZ, he decided that anyone who could do this could make his flowers. In 1886 he journeyed to Dresden to enlist the father and son for the long and difficult project. After some reluctance they agreed, and the result after 50 years of work was some 847 life-sized models, and over 3,000 detailed models of enlarged flowers and plants.

Near the Botanical Museum is the Peabody Museum of Archaeology and Ethnology, which was founded by George Peabody in 1866. It houses one of the country's oldest and best anthropology collections.

The Middle and South American archaeology collections are exceptional. The section of gold pieces from Central and South America includes a hammered gold greave (ceremonial leg armor), which was found in a grave in Panama. The burial site contained the skeleton of a very old man covered with gold jewelry, including hammered discs, cast pendants with precious stones, and cuffs. The highly stylized design in the greave shows two crocodiles, teeth bared, attacking each other. The crocodiles' tails are raised and terminate in cagles. From the same culture, the Cocle, is a haunting, hammered gold disc of a stylized human face, with closed eyes (possibly signifying death) and bared teeth showing fangs. According to archeologists

the pieces were created by hammering out gold nuggets and heating the metal. When the gold was in a flattened, disc shape the pattern was hammered into the plaque.

Before leaving the Peabody, be sure to view the great Benin bronze plaque, dating from the late 1500s or early 1600s. It portrays the Benin chief decked in a helmet with feathers, carrying a spear and decorated shield. In the background are two Portuguese soldiers. The Kingdom of Benin was just reaching its peak during the first contact with European civilization, and the plaques, created to show the wealth and power of the king, lined passageways in his palace.

Harvard's Mineralogical Museum, like the Peabody, houses one of the oldest and finest collections in the United States. The section on New England minerals—showing beautiful tourmalines from Maine, amythests from Rhode Island, and other rare minerals—may urge you out to the abandoned mines in those states to look for more. More knowledgeable rock hounds will be pleased to know that the Museum has one of the two finest specimens of Red Cloud wolfenites, the largest jeremejevite crystal known, several alexandrite twins measuring two inches in diameter, and a "single terminated deeply colored hiddenite crystal from North Carolina, over two inches long," according to one account.

The Geological Museum next door has been recently renovated, and includes two 18-foot panoramic photographic murals showing a before-and-after picture of Mount St. Helens. The physical results of an eruption are on display, including ash, lava, pumice (a kind of hardened frothy lava that floats on water), and other volcanic curiosities.

MUSEUM OF NORTHERN ARIZONA

ROUTE 4, BOX 720, FLAGSTAFF, AZ 86001. Tel: (602) 774-5211.

Hours: Sun–Sat 9 am–5 pm, closed Thanksgiving, Christmas, December 31st and New Year's.

Admission: $2 adults, $1 full-time students 5–21.

Publications: Publications reflect diverse subjects researched by museum staff and associates; these include:

Archaeology Research Series. 18 volumes.

Edwin Coldbert, *Dinosaurs of the Colorado Plateau*. 1983, $4.

Grand Canyon Biology. 1977, $1.50.

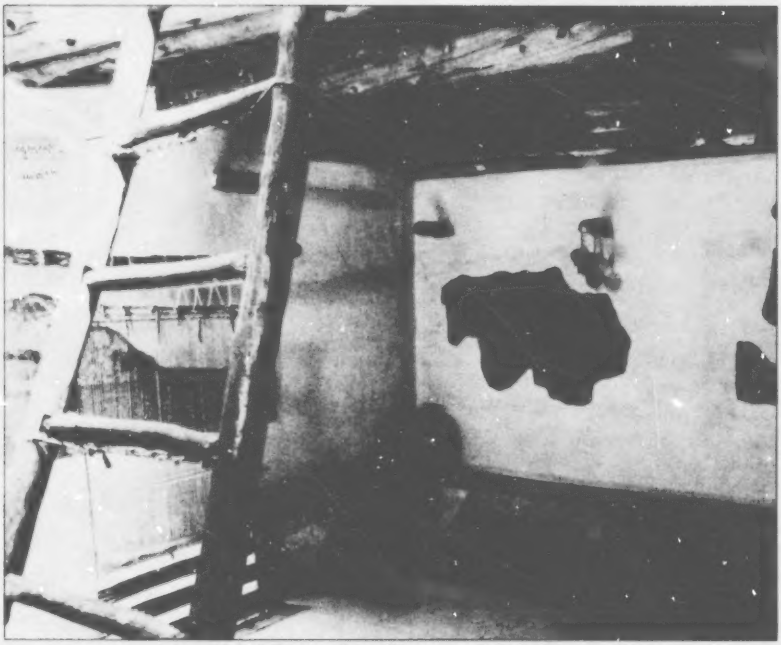
Troy L. Pewe, Randall G. Updike, *The San Francisco Peaks: A Guide to the Geology*. 1976, $2.50.

Plateau. quarterly, $4 per issue.

Reproductions: Posters, postcards and fine art reproductions of works in the collection and special exhibitions.

Research: Reference library open to public. Limited amount of laboratory and research space available upon submission of proposal to curator of specific department.

The Museum of Northern Arizona was built in a natural area of incomparable beauty. Its building of stone and wood, with a red-tile roof, is surrounded by a beautiful stand of ponderosa pines. Behind it rises the magnificent San Francisco Peaks, clad in snow for months out of the year.



This life-sized replica of a Hopi kiva contains fragments of wall murals, an antique jar and a reconstructed loom.

The Museum, which looks like it could have once been a hacienda, focuses on the area known as the great Colorado Plateau of the southwest. It's not a bad subject for a museum, since it covers a tremendously rich geologic and prehistoric area from the Grand Canyon and its unparalled billion-year record to the two-mile-high San Francisco Peaks. It encompasses an area rich in plant and animal life, sprinkled with ancient ruins but still inhabited by vigorous native American cultures such as the Hopi and Navajo.

The interior of the Museum combines the nineteenth-century feeling of massively timbered rooms with superb modern exhibition design. Probably the finest exhibit is the "Native Peoples of the Colorado Plateau," which has as its centerpiece a full size restoration of a Hopi Kiva based on the one discovered at the prehistoric site of Awatovi. Some of the ancient wall murals discovered in the Awatovi Kiva have been incorporated into the exhibit. A great many prehistoric and modern artifacts are displayed here, drawn from the Museum's extensive collections, which were begun in the late 1920s in response to fears that Eastern archeologists were emptying the most important Northern Arizona sites for their own museums back East. But rather than the "show all, tell little," school of museum exhibition, the artifacts are integrated into a much larger cultural and archeological

framework—a woven basket becomes an important ceremonial object, an abstract pattern on a woven rug takes on a larger symbolic meaning, a delicately floked spearpoint becomes a tool that shaped the way of life of an ancient people.

Since the Colorado Plateau has been continuously inhabited by man for 11,000 years, the Museum does not neglect modern native American arts and crafts. In July of every year, the museum mounts the annual Hopi and Navajo Shows, in which one can see the transformation of ancient designs and symbols into modern jewelry, weaving, and carving. The annual shows are a focal point for some of the finest Indian craftsmanship in the area.

The present director of the Museum of Northern Arizona recently termed it "one of the gems of the museum world." We wouldn't disagree with that.

NATIONAL GEOGRAPHIC SOCIETY—EXPLORER'S HALL

17 AND M STREETS NW, WASHINGTON, DC 20036.
Tel: (202) 857-7588.
Hours: Mon–Fri 9 am–6 pm, Sat and holidays 9 am–5 pm, Sun 10 am–5 pm.
Admission: Free.
Publications: The Society publishes a magazine and numerous books for adults and children; these include:

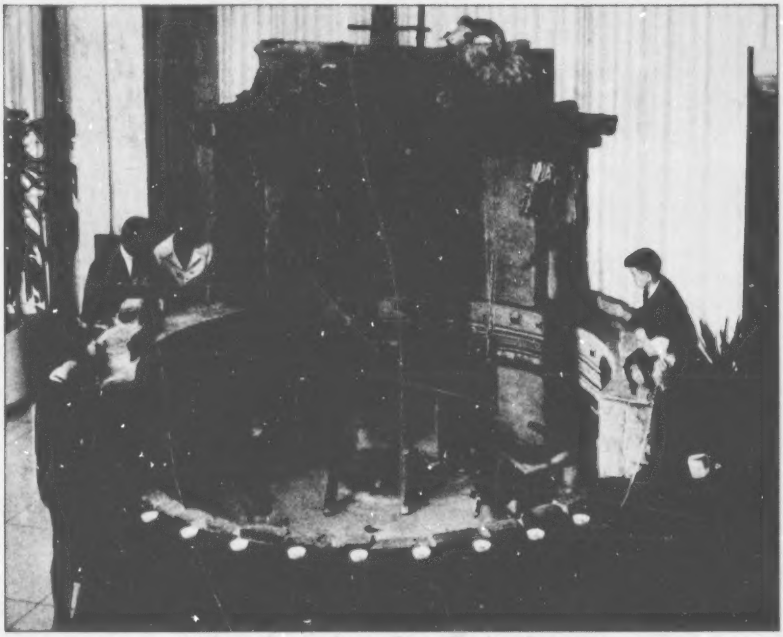
Thomas B. Allen, *Images of the World*. 1981, $18.95.
Journey into China. 1982, $19.95.
Our Living Planet. nd, $19.95.
The National Geographic Magazine. monthly, $15 per year.

Reproductions: None.
Research: Reference library open to the public.

Next to the giant museums of Washington, D.C., the Explorer's Hall might seem a little insignificant. This impression is quickly dispelled upon stepping inside this enchanting little museum. The hall wisely has made no effort to connect the exhibits into one scheme; instead, the visitor is surprised and delighted by the unexpected: the flag Peary planted on the North Pole next to a giant Olmec head; or a moon rock just down the hall from an extinct, flightless bird from Madagascar.

The focal point of the Hall is the great National Geographic Globe, a 1,100 pound replica of the earth in aluminum and fiberglass. The distance from Boston to Peking is about 11 feet through the center or about 17 feet if you go the long way. The globe is tilted at a 23.5 degree angle (same as the real earth to the ecliptic) and rotates on its axis. For special demonstrations, the operator can lift the globe from its spindle and rotate it in any direction to reveal any part of its surface.

Across from the Olmec Head is an exhibit of Cliff Dwellers of the Southwest, showing a kiva (ceremonial room) of Wetherhill Mesa in Southwest Colorado, a site whose excavation was supported by the National Geographic Society. A diorama shows the underground room of the kiva, where one figure decorates a wall and another weaves a blanket, while a boy watches. Next to the kiva is a skeleton from a cliff-dweller burial.



Visitors learn through audiovisual means that for some Native American groups, the kiva was a major center of culture.

The hall often includes temporary exhibits of many subjects, from toy soldiers to magnificent color photography.

NATIONAL MUSEUM OF NATURAL HISTORY

SMITHSONIAN INSTITUTION,
CONSTITUTION AVENUE AT 10TH STREET,
WASHINGTON, DC 20560. Tel: (202) 357-2700.

Hours: Sun–Sat 10 am–5:30 pm, summer hours may extend into the evening; closed Christmas.

Admission: Free.

Publications:

Philip Kopper, *The National Museum of Natural History*. 1982, $60.

Official Guide to the Smithsonian. 1981, $3.

Smithsonian Contributions to: various departments; monographs and occasional papers.

Reproductions: Posters, prints, postcards and other reproductions of objects in the collection.

Research: Library open to persons with legitimate concerns upon request. Museum encourages visiting scholars, researchers and students to use the more than 65 million specimens; make appointment with specific departments.

On October 26, 1823, an eccentric Englishman named John Smithson, illegitimate son of the first Duke of Northumberland, composed his last will and testament. In it, he left his considerable fortune to a country he had never seen, a country disparaged by many of his fellow-Englishmen: The United States. The bequest was, in his words, "to found at Washington, under the name Smithsonian Institution, an Establishment for the increase & diffusion of knowledge among men." After Smithson's death, the contents of the will became known to the U.S. Charge d'Affairs in Britain. The fellow reported it to the U.S. Secretary of State in a letter:

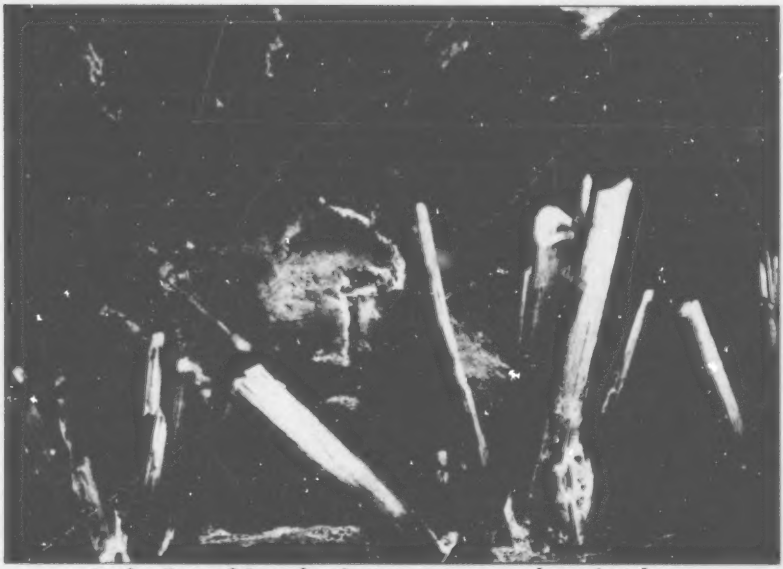
> The papers which I have the honor herewith to communicate to you will acquaint you with the particulars of a Bequest. . . . The caption of the will is in language which might induce a belief that the Testator labored under some degree of mental aberration at the time it was made.

This was the beginning of the Smithsonian Institution. The National Museum of Natural History is one of the Smithsonian's dozen or so museums, and was one of the first to grow out of Smithson's bequest. It is one of the preeminent natural history museums in the world today. Its halls and storerooms include practically every representative thing which is collectible from the world of man and nature—from pickled minnows and Peruvian mummies to diamonds and miniature orchids.

With so much to write about, we might as well start with the most famous object in the Museum, and one of the most viewed objects in the entire world: the Hope Diamond. It rests in a glass-fronted vault in the museum's Hall of Gems in a somewhat garish setting made for its last private owner, the American heiress Evalyn Walsh McLean. The pale blue diamond is almost too large to be real, being over one inch in diameter and weighing 45.5 carats. The myths we sometimes hear about the Hope (that it was stolen from the eye of an idol and carries an evil curse) were fabricated by a former owner, the jeweler Pierre Cartier, who had a touch of P.T. Barnum about him. We do know that the stone was carried out of India in 1642 and sold to Louis XVI; it remained one of France's crown jewels until the Revolution, when it was apparently stolen and recut. Thirty years later an English collector named Hope purchased the largest recut piece. From the Hope family it eventually made its way to Cartier and thence to Mrs. McLean in 1911, who sported it for almost 40 years. The jeweler, Harry Winston, gave it to the Smithsonian in 1958.

The Hope is one of many fabulous gems in the hall. Notable among the diamonds are the 127 carat Portuguese diamond, the champagne-colored Victoria Transvaal diamond, and the deep blue Eugenie Blue diamond. (There is almost a surfeit of diamonds in the hall: in one piece of jewelry alone, the Empress Marie Louise tiara, there are 950 diamonds).

In the adjacent mineral hall one can view a mineral named after Smithson, a sunny green mineral with small crystals called Smithsonite. The minerals are as dazzling as the gems. Here, in one case, is a gargantuan gold nugget weighing over five pounds; not far away is a cluster of gypsum crystals from



In the Cave of Swords, giant gypsum crystals project from the floor. Further on, a narrow passage is completely lined with blade-like crystals forming a corridor of swords.

the Cave of Swords in Mexico. Also on display are several intricate agates with hundreds of concentric layers of colored mineral, a gypsum "flower" curling weirdly out of its rock base, a cluster of thin, rapier-like stibnite crystals looking like a porcupine, a blood-red cluster of rhodochrosite crystals from the Kalahari desert, and a raw opal imbedded in its rocky matrix where it precipitated out of silica-laden groundwater.

The Plains Indian exhibit (to jump around a bit) is equally impressive. On display is a series of "ledger book" drawings, showing scenes of battle and courtship painted and drawn by Plains Indian warriors. The Plains Indians often painted incidents in their lives on the flesh side of buffalo robes and teepee covers, using earthen pigments. During the nineteenth century, U.S. manufactured ledger books, pencils, crayons, and watercolors replaced the earlier materials because they were easier to use, and the ledger books could be carried into battle. On display is an extraordinary series of drawings of the Battle of the Little Bighorn (Custer's Last Stand), made by Chief Red Horse, one of the Indian leaders. The first drawing pictures the Indians' encampment, a thicket of teepees, before the battle. A few examples of the following drawings give an accurate picture of the battle itself: one page shows a field strewn with bullet-riddled U.S. Cavalry horses with one American flag lying on the ground; in another drawing the Indians pursue the fleeing cavalry and (significantly) many riderless horses; a third drawing simply shows the ground marked with hundreds of hoof prints;

and a final scene details four wounded and bleeding cavalry soldiers being overtaken by Indian warriors. A second example of ledger book art was made by Sitting Bull, and is signed with his authentic, childlike signature (he learned to write it while with Buffalo Bill's Wild West Show).

Most natural history museums have a scientific staff connected with them, which does research in the fields of systematic zoology, taxonomy, and evolution—all of which require the examination of specimens. Evolution Hall at the Museum gives an idea of what this study is all about. At the entrance to the Hall is a glass case crammed with the raw evidence of evolution—jars full of pickled specimens, skulls in different sizes and shapes, pine cones, corals—in short, representative samples of particular species showing variation in nature. In the hall itself the process of evolution is explained using materials from the Museum's study collections, providing a framework for understanding the other exhibits in the Museum. In the balcony of the hall is suspended a great blue whale's skull—which is larger than any skull of any other species of animal that ever lived (even larger than all the dinosaurs!). It is a powerful testament to the rich and fantastic diversity of life on earth.

Another example of diversity can be seen in the Age of Mammals section of Fossils: "The History of Life." A series of murals by the artist Jay Matternes pictures a number of extinct forms of mammals that evolution produced. In one mural a herd of gomphotheriums stroll across a Pliocene Age prairie, swept by a rising wind from a thunderstorm brewing on the horizon. In another mural, a group of extinct peccaries gather at the edge of a swamp to drink while in the background a pair of megatheriums (a twelve-foot-high ground sloth) feed on succulent swamp grasses. The twentieth-century evidence of these early beasts is also on display in a series of spectacular fossils—including a 16-foot-tall fossil of callixylon, one of the earliest trees, stretching from floor to ceiling. The same ground sloth mentioned above is in the hall, rearing to a height of 20 feet. At the very beginning of the exhibit hall is an unremarkable looking rock with reddish striations. The rock is the remains of extremely primitive algae growing in the waters of a shallow sea *3.5 billion years ago.* They are the oldest evidence of life on the planet, and, in fact, not far removed from the first life forms from which *all* life is descended.

No one knows exactly what kind of institution James Smithson had in mind when he penned his will. But the National Museum of Natural History, with its 63,882,526 specimens (give or take a million) probably covers the bases pretty well.

GEORGE C. PAGE MUSEUM OF LA BREA DISCOVERIES

5801 WILSHIRE BOULEVARD, LOS ANGELES, CA 90036.
Tel: (213) 936-2230.
Hours: Tues–Sun 10 am–5 pm, closed Mon, Thanksgiving, Christmas, New Year's.
Admission: $1.50 adults, $.75 senior citizens, students, children over 6; free on second Tuesday each month.

Publications:

Introducing the George C. Page Museum of La Brea Discoveries. 1977, $1.

Chester Stock, *Rancho La Brea: A Record of Pleistocene Life in California*. 1972, $2.50.

Also, scientific monographs on paleontology.

Reproductions: Posters, postcards, slides and plaster casts of skeletons from the tar pits.

Research: Research library open by appointment.

The Natural History Museum of Los Angeles County is divided into two parts, the excellent Natural History Museum at Exposition Boulevard and the George C. Page Museum, adjacent to the La Brea Tar Pits. The Natural History Museum is definitely worth a visit. However, if you don't have time to see both, then we recommend the Page Museum, a remarkable and unique showcase.

In 1769, a missionary in California named Father Crespi made a note in his journal about several "springs of pitch." He observed that the pitch, which oozed from the ground and formed puddles, was excellent for building fires. The pitch was excellent for something else as well—the trapping and preserving of thousands of prehistoric animals. Father Crespi had discovered the famous Tar Pits of Rancho La Brea.

The Tar Pits are areas where oil has risen to the surface and hardened into a sticky asphalt-like substance. For 35,000 years, the tar has been a trap for all kinds of animals, from huge imperial mammoths to dire wolves, saber-tooth cats, and even tiny insects and birds. The pits were especially dangerous when they became covered by wind-blown sand and grass, or a skimming of water. Animals venturing on to the disguised surface were trapped; the cries and howls of the hapless creatures then became a magnet for predators and scavengers, who would themselves become trapped. Nor was death swift, since the asphalt was slow and viscous; most animals died of starvation or thirst. As the months passed their carcasses gradually sank into the mire, to join thousands of skeletons lying in the depths of the tar. The La Brea Tar Pits are now in the bustling heart of Los Angeles, just off fashionable Wilshire Boulevard. Next to the pits (which are now enclosed by fences) is the brand-new George C. Page Museum, a showcase for this, the greatest Pleistocene graveyard ever discovered.

The Museum looks like a low, grassy pyramid from the outside. The interior of the Museum is sunken below ground level, and contains an atrium with a meandering stream and winding paths. Descending into the Museum is a little like entering a burial mound, a peculiarly appropriate sensation.

Two exhibits highlight what the tar pits are all about. One, called "Asphalt is Sticky," displays several containers of the kind of tar found in the pits with dipsticks. Visitors are challenged to try to pull out the sticks, giving a sense of the kind of force an animal might need to pull free of the substance. (Now we know why even the powerful cats and wolves were doomed, once having stepped in the stuff.) Near this exhibit is the La Brea Woman, the skeleton of a California Indian who was caught in the tar about 9,000 years ago; it is the

The fossils in this case are the remains of a woman found at the Tar Pits. She was caught in the tar about 9,000 years ago.

only human ever found in the pits. Looking at the dark skeleton, one can almost sense the fear and despair of this woman's last moments. Special lighting techniques cause the skeleton to fade in and out with a three-dimensional model of how the woman may have looked in life.

Visitors get a glimpse of how paleontologists do their work in an observation laboratory in the Museum, where scientists prepare fossils that have been recently found in the ongoing excavations. A nearby exhibit gives a graphic idea of exactly how dense the fossil beds are at La Brea; the exhibit consists of a four-foot cube of the hardened asphalt excavated from an old bed. It is literally crammed with bones. Next to it is a transparent cube of the same dimensions also filled with fossils, in the same position they were discovered, showing the density and distribution of bones in the tar.

Much of the Museum is taken up with mounted skeletons and skulls of such former inhabitants of California as the 12-foot-high imperial mammoth whose ten-foot curling tusks arc over the heads of the visitors. Here too, are American mastodons and extinct camels, dire wolf fossils, a giant ground sloth, saber-tooth cats as well as American lion skeletons, birds, plants, and a bear.

The Museum is an example of exhibit design at its best. The designers (it must have been a blast to design this museum!) have combined audio-visual exhibits, graphics and panels, murals, and laboratory areas with fossil displays to a make top-notch museum.

PEABODY MUSEUM OF NATURAL HISTORY

YALE UNIVERSITY, 170 WHITNEY AVENUE,
NEW HAVEN, CT 06511. Tel: (203) 436-0850.

Hours: Mon–Sat 9 am–4:45 pm, Sun and holidays 1–4:45 pm, closed Thanksgiving, Christmas, New Year's, July 4th.

Admission: $1 adults, $.50 children 5–16, free to children under 5.

Publications: Scientific publications are:

Bulletin of the Peabody Museum of Natural History. monographs in biiology and geology, published irregularly.

Postilla. monographs less than 100 pgs. published irregularly.

Popular publications are:

Discovery. semiannual magazine, $12 per year.

Discovery Supplements.

Reproductions: Postcards of objects in the exhibition; reproductions of the murals.

Research: Reference libraries open to students and scholars engaged in serious research by appointment. There are branches in ornithology and entemology. A scanning electron microscope is available for a fee.

The first director of the Peabody Museum of Natural History at Yale University was the irascible and brilliant Othniel C. Marsh, Professor of Paleontology, whose uncle, George Peabody, had founded the Museum with a $150,000 donation. Marsh was one of the world's great collectors of dinosaur bones, and he was the archrival of another dinosaur collector named Edward Drinker Cope. When the rich dinosaur bone quarries began opening up in the West in the late nineteenth century, Marsh and Cope became locked in a bitter competition to discover and name the most new species of dinosaurs. Both men poured their personal fortunes into the search, and railroad cars stuffed with bones rolled toward the natural history museums of the East.

One result of this rivalry is the spectacular dinosaur collection at the Peabody Museum, which received most of Marsh's specimens. Upon entering the Museum and turning right, the visitor is brought face-to-knee with Marsh's greatest find—*Brontosaurus excelsus*. He unearthed the skeleton at Como Bluff, Wyoming, in 1878 and named it (loosely translating from the Latin) "Thunder Lizard Unsurpassed." (The *excelsus* was inspired by the completeness of the skeleton, which even today is one of the most consummate Brontosaurs ever found.) In the hall surrounding the beast are other extinct animals—a duckbilled dinosaur, which was the first dinosaur mounted in the New World; a stegosaurus (whose walnut-sized brain has given all dinosaurs a bad reputation); the pterodactyls; and a replica of a Tyrannosaurus skull with dangerous-looking fiberglass teeth.

But dinosaurs, however extraordinary, inhabit many natural history museums. The Yale Peabody Museum is better known for something else: its colossal "dinosaur mural," officially known as the Age of Reptiles. It is said to be the world's largest natural history painting, measuring 16 feet high by 110 feet long. It took the artist, Rudolph Zallinger, four and one-half years to cover the 1760 square feet of dry plaster with paint, a Michaelangelean

Detail of the "Age of Reptiles" mural shows a towering Brontosaurus, foreground, a Stegosaurus, right, and a Tyrannosaurus, far right, in a late Cretaceous setting.

effort that won him a Pulitzer Prize. The mural was reproduced in the *Life* magazine series, "The World We Live In," and was reprinted in the Nature/Science Library. This mural, probably more than anything else, is what formed most people's conception of what prehistoric life looked like. In fact, its primeval landscapes overrun with dinosaurs look almost clichéd today.

The mural begins in a reeking Devonian swamp, circa 350 million B.C. and ends 110 feet later in a classic, late Cretaceous setting with smoking volcanoes and a pteranodon wheeling in slow circles overhead. The mural spans 280 million years of earth history (that's 212,000 years to the inch), with literally volumes of scientifically accurate information incorporated into it.

As we move forward in time (gazing at the mural) we first witness the emergence of a queer, squashed-looking amphibian called eryops, one of the first tetrapods to successfully colonize the land. In the Permian Age the dimetrodon with its sail-like fin appears, framed by odd-looking scale trees and early conifers. In the Triassic we see the emergence of the first "classic" dinosaurs as well as the curious, fleet-of-foot podokesaurus, known only from one incomplete skeleton. Finally, as the age of dinosaurs reaches its peak in the Jurassic and Cretaceous, in come the brontosaurus and stegosaurus. The crown jewel of the mural is Zallinger's tyrannosaurus, a wonderfully evil looking slate grey beast, gazing with half-lidded eyes at the strange world around him. The mural ends at the Cretaceous/Tertiary

boundary when the worldwide, mass extinctions saw the end not only of the dinosaurs but thousands of other animals as well.

Soon after finishing the dinosaur mural, Zallinger embarked on another ambitious painting which would conclude the story of life on earth. The new work, displayed in the Hall of Fossil Mammals, shows the evolution of mammalian life from the beginning of the Tertiary Age to the peak of the last Ice Age some 15,000 years ago. This work, on a slightly more modest scale, measures only 5½ feet by 60 feet, and spans just 65 million years of earth history. The setting of the painting is the region of the present Great Plains and Rocky Mountains of North America, where so many fossil mammals have been found. Although this mural lacks the sheer magnificence of the "Age of Reptiles" it is still an outstanding achievement. Because it involves a smaller time scale (only 90,000 years to the inch) and a better-known fossil and geological record, the artist and his scientific advisors were able to include much more detail; they were even able to reconstruct reasonably accurate North American landscapes.

The parade of mammals begins inauspiciously with a few self-effacing shrew-like creatures, but from these the process of evolution soon yields horses, woolly mammoths, giant sloths, bears, bison, and a host of other large and strange mammals. *Homo sapiens*, the most interesting (to us) product of mammalian evolution, is not represented here. Visitors who wish to study this unusual primate will have to visit the Peabody's anthropology and archeology exhibits.

By far the most splendid of the Peabody's anthropology collections is the exhibit, "Mexico to Peru." The University sent a great many important expeditions to South America, including Hiram Bingham's 1911 trek to the headwaters of the Ucayali river, where he discovered the fabulous lost Inca city of Machu Picchu. As a consequence Yale has perhaps the finest collection of Inca artifacts in the world, including painted pottery dishes, bronze knives, bowls, carved stone vessels, and water jars. The exhibit also displays one of only a few Aztec calendar stones, bought at a fire sale by Othniel C. Marsh in 1887. (In addition to his dinosaur pursuits, the irrepressible Marsh founded the museum's archeological collections.) The stone illustrates the Aztec myth of the five successive creations of the universe. The colossal visage of a Mesoamerican Ozymandias guards the entrance of the hall, a replica of the head of an Olmec ruler unearthed by a Yale Expedition in 1967. Other pieces in the hall include a number of lost-wax cast gold pendants of animals such as turtles and jaguars, a pottery stool from Panama whose supports are bisexual animal figures, and an example of a *quipu*, or knot-record, used in accounting by Inca bureaucrats.

The scope of the Yale Peabody Museum ranges from butterflies to meteorites. Apart from everything else, the museum is worth a visit, if only for Zallinger's magnificent *Tyrannosaurus rex*.

PLANET OCEAN

3975 RICKENBACKER CAUSEWAY, MIAMI, FL 33149.
Tel: (305) 361-9455.

Hours: Sun–Sat 10 am–6 pm.
Admission: $5 adults, $2.50 children 6–12, free to children under 6 and members of the International Oceanographic Foundation.
Publications: Popular publications are:
Sea Secrets, a newsletter.
Sea Frontiers, published bi-monthly.
Reproductions: Slides.
Research: Library for staff only.

The idea behind Planet Ocean was born during a trip to Disneyland by a man who, fortunately, had probably not visited the place as a child. Planet Ocean's founder, F.G. Walton Smith, said about the experience: "The innovative techniques and devices used at Disneyland to project fairy tales and fantasies made a great impression on me." He reasoned that such dramatic techniques could just as easily be used to explore the real world—especially the 75 percent of it covered by the oceans. Thus Planet Ocean was conceived.

The Deep Diver Submarine, now at Planet Ocean, set diving records in 1968 by taking four men down 700 feet so they could go outside of the sub.

One of the most fascinating rooms at Planet Ocean is not an exhibit at all. The entire museum is operated from a large "control room" whose walls are lined with humming computers, continuous-loop audio-visual tape machines, amplifiers, and a battery of other electronic and audio equipment that monitor and control all the major exhibits.

The exhibits themselves do not involve the kind of objects, specimens, and artifacts you find in other museums. Scientific concepts and ideas are presented á la Disney, with dynamic "action" exhibits that render them dramatically. Learning panels scattered throughout the exhibits provide the theory behind the action.

How does one present an iceberg (especially in Florida) or a hurricane? Smith's answer was simple—show the thing itself. Visitors, protected by thick glass, can step into the middle of a raging hurricane, complete with howling winds, flashes of lightning, thunderclaps, and lashing rain. A barometer shows sinking atmospheric pressure and a wind gauge measures 100 mph gusts. At the end of the tunnel, the visitor whose interest has been whetted by the storm can learn about the internal dynamics of a hurricane on a computer-controlled double film of its circular form with a wedge sliced out to show wind patterns.

Similarly, Planet Ocean exhibits an "authentic" iceberg (or rather the tip of it, projecting out of the floor.) The thing is real ice, and visitors are encouraged to touch it, climb on it, and see how much of it they can melt. The melted holes are regularly patched with crushed ice, while an internal copper coil filled with freon keeps it frozen.

Another Disney technique expropriated for Planet Ocean is the "moving walkway," but instead of entering a pirate's lair or a haunted house, visitors are sent through the lens of a microscope and into a drop of seawater. Huge, three-dimensional diatoms and other microscopic animals float in the darkness, extending in all directions apparently to infinity. Actually, they are images projected on spheres to give them three-dimensionality, then reflected and re-reflected in mirrors.

Multi-screen films illustrate one of the museum's central themes, Birth of an Ocean. A wrap-around theater using seven screens and 21 projectors (computer controlled, of course) shows the formation of the earth and its oceans and continents and the origin and development of life. The vast time scale of earth history is dramatically illustrated by compressing the 4.5 billion years into a single "year," projected in a series of images on one screen. In that year, mankind does not emerge until a few minutes before midnight on New Year's Eve, just before the popping of the champagne.

Planet Ocean is filled with delectable facts and involving exhibits. You can walk through an indoor cloud, look through the jaws of the largest shark that ever lived, listen to the ghost of an old salt recount stories of sea monsters, look at the smallest sailboat to cross the Atlantic (five-feet, eleven inches), and even ask questions of a dummy diver named Sam.

Planet Ocean has successfully proved Smith's belief that "facts—even those about a drop of water—can be and are as thrilling as any fiction dreamed up as entertainment."

SCIENCE MUSEUM OF MINNESOTA

30 EAST 10TH STREET, SAINT PAUL, MN 55105. Tel: (612) 221-9488.

Hours: Mon–Sat 9:30 am–9 pm, Sun 11 am–9 pm; closed Monday during school year; closed Thanksgiving, Christmas.

Admission: $3 exhibits only, $4.50 omnitheater, $5.50 combined admission; reductions for senior citizens and children.

Publications: Scientific publications include:

Breviora: published irregularly

Monographs of SMM: published by separate departments.

Popular publications include:

Encounters, magazine for members including popular discussions of museum holdings.

Bruce Erickson, "Legacy of a Cowboy Paleontologist: Ray E. Lemley Collection."

Reproductions: Posters, prints and postcards of objects and exhibits in the museum.

Research: Reference library open to students and interested persons by appointment. Science departments have limited research facilities for scholars working with staff.

These children, with the help of a volunteer, are modeling masks in the style of the Northwest Coast Indians.

The Science Museum of Minnesota refutes the generalization that natural history museums do not lend themselves to "interactive" exhibits. (An "interactive" exhibit in the jargon of museology is one in which the visitor can push buttons, turn cranks, or otherwise become involved).

A beautiful example of the museum's unusual and effective exhibits is the second floor, devoted to anthropology. Instead of dividing the floor into cultures, like a standard exhibition, the displays are based on cross-cultural themes, such as "The Hearth," "Myths, Masks, and Magic," "Harvest," or "Weaving."

Every culture has its hearth, whether it be an open-pit fire or a Westinghouse oven. The hearth is a powerful concept in most human cultures, symbolizing the home, family life, warmth and nourishment. The Hearth exhibit combines displays of various hearths with artifacts such as bowls and utensils, but the most important part of the exhibit is the "demonstration area." Here, museum staff involve visitors in such activities as natural dyeing (done in warm water at the hearth), or food preparation.

Another especially clever exhibit is "Myths, Masks, and Magic," again drawing on a powerful and omnipresent aspect of human society. In this area, to learn about face-painting, the visitor can put his face into a box containing hidden slide projectors. At the touch of a button the face is instantly "painted" as an African from the Sudan or a Tlingit from the Northwest Coast of America. The point of the demonstration is to encourage visitors to see face-painting as another way to express one's role, status, or membership in a group. Instead of a static (and silent) display of musical instruments behind glass, a museum staff member wheels in the "Music Cart," laden with exotic instruments. Visitors are shown how to play them, and improvised jam sessions are often set up (with the resultant cacophony giving visitors an added appreciation for "primitive" music.)

The Hall of Technology, a recent addition to the museum, has equally ingenious interactive exhibits. You can learn about simple computer programming by playing with the "turtle," a small, dome-shaped robot controlled by a computer. You can tell the computer to move the turtle to any destination in its "cage" using computer commands typed into a keyboard. The success or failure of your efforts immediately becomes apparent in the bumbling progress of the turtle as it follows the computer's interpretation of your commands.

The museum has both the earliest and latest in moving picture technology. In the hall, you can make a zoetrope, the first type of moving picture, by drawing on long strips of paper which are placed on a rotating drum with slits. When the drum is spun, a moving picture appears. In another part of the Museum is the new Omnitheater, which shows Omnimax films—one of only 15 or so theaters in the world with the Omnimax system. The system was recently developed by a Canadian company, and it projects the film onto a huge, planetarium-like dome, completely surrounding the viewer with the picture. Omnimax films must be shot using a special camera and extra-large sized film (each frame is five square inches): it can only be projected with a machine the size of a Cadillac car. The system's ability to

create cinematic realism is unsurpassed, thus making it one of the best "interactive" exhibits of all.

TEXAS MEMORIAL MUSEUM

UNIVERSITY OF TEXAS, 20400 TRINITY STREET,
AUSTIN, TX 78705. Tel: (512) 471-1604.

Hours: Mon–Fri 9 am–5 pm, Sat–Sun 1–5 pm, closed major holidays.

Admission: Free.

Publications: Scientific publications include:

Bulletin Series. Occasional series of technical monographs primarily on museum research.

Pearce-Sellards Series. Occasional series of short technical reports.

Other publications and reprints.

Popular publications are:

W. Langston, *The Onion Creek Mosasaur*. 1966, $.75.

Museum Notes. Booklets describing exhibits.

Reproductions: Posters, postcards and prints of objects in the collection and environs.

Research: Reference library open to students, scholars and interested persons by appointment.

A rare, elaborately designed North American Indian basket made with tightly-coiled construction.

The Texas Memorial Museum was established during the Texas Centennial of 1936 for, among other things, "exhibits of natural and civic history." It may be the only museum established in part with funds from the sale of a specially minted U.S. half-dollar.

It is not surprising, therefore, that the museum should have an outstanding collection of rare coins and medals, assembled by the Swedish Baron A.W. Stjernstedt in the late 1800s. The coins, which date from 500 B.C. to the Middle Ages, are made of gold, silver, or bronze; some were struck while others molded; some show pagan gods, others portray emperors (some exhibits even show long-lived emperors growing older on a series of coins). As a glimpse of history, trade, and society they are quite fascinating.

Another example of "civic history" is the Museum's collection of weapons. Perhaps more in the line of anthroplogy than art or history, the weapons exhibits show the way man has increased his ability to hunt, defend, and offend over the centuries. It also reveals man's creative impulse, which leads him to decorate everything—even his weapons—to turn them into objects of great beauty and craft. Just about every device of weaponry is shown. From a toggle harpoon to ivory-handled duelling pistols, knives, daggers, maces, bows and arrows, cannons, flintlocks, wheellocks, and matchlocks—all are included. Among the finest pieces on display is a pair of ivory flintlocks from Holland with exquisitely carved handles showing two helmeted classical heads; and a massive flintlock musket carried by Mr. Thomas Bickford of New Hampshire during the Revolutionary War.

In a more "natural history" vein is a delightful collection of Mexican toys, containing pull-toys, airplanes, and figurines from both popular and Christian folklore, made of plaster or papier mache.

The fine Barton Mineral Collection in the museum features minerals from the Third Geological Survey of Texas in the 1880s, along with many other beautiful mineral specimens of Texas origin. At the museum are some woven Pre-Columbian textiles, including intricate examples from Paracas, where the dry climate has preserved them intact for thousands of years.

UNIVERSITY OF COLORADO MUSEUM

HENDERSON BUILDING, CAMPUS BOX 218, BOULDER, CO 80309.
Tel: (303) 492-6165

Hours: Mon–Fri 9 am–5 pm, Sat 9 am–4 pm, Sun 10 am–4 pm; closed on university holidays.

Admission: Free.

Publications: Museum publishes scientific reprints in various fields; other publications include:

Natural History Inventory of Colorado Part I–VI. 1979–81.
Hugo G. Rodeck, *Natural History of the Boulder Area.* 1973, $2.15.
William A. Weber, *Rocky Mountain Flora.* 1976, $9.50.

Reproductions: None.

Research: A small general library; each curator maintains separate reference collection. Library open to anyone who follows necessary check-out and return procedures.

A characteristic abstract design found on pottery from the Anasazi sites in the Southwest.

The University of Colorado Museum was launched in 1902 by one Junius Henderson, a lawyer, judge and dabbler in paleontology. The Museum's original exhibition space occupied the upper floors of a science building on the University's campus. According to those who knew it then, "it had all the appearance of a nineteenth-century collector's cabinet." The glass cases stuffed with specimens were crowded so close together that the visitor had difficulty even moving among them. In 1937, the museum was transferred to a new building (named after Henderson) and nearly two hundred truckloads of specimens, artifacts, objects and bric-a-brac were hauled out of the old building and installed in the new.

The primary focus of the Museum is regional—the flora and fauna of the Rocky Mountain area. It is (unofficially) the state's natural history museum and repository, but its collections embrace the world.

The Museum has an exceptional collection of archeological material from the Southwest, primarily the work of Earl H. Morris. Morris excavated thousand-year-old Anasazi (Basket Maker-Pueblo culture) sites from 1913 to the 1940's, and uncovered thousands of pottery vessels. Many are splendidly decorated with the characteristic abstract designs or exposed coils characteristic of Anasazi pottery. He also recovered stone and bone tools, baskets, textiles, and even sandals. Some of the best of these artifacts are on display in the Hall of Man in the large section on southwestern archeology. Also

displayed are musical instruments and jewelry and fascinating dioramas showing how the culture evolved and developed through time. Smaller exhibits on the Indians of the Plains, Northeast and Northwest Coast provide an interesting comparison.

The McKenna Room houses a surprisingly beautiful collection of Oriental carvings, including small and sometimes humorous Japanese netsuke, glass and stone snuff bottles with tiny ivory spoons, ceramics, tapestries, scrolls, fans, silver and jade jewelry, clothing and other objects.

Most of the exhibits in the Colorado Museum have an old-fashioned flavor. Although the Museum's exhibits do not represent state-of-the-art exhibit design there is a certain bygone charm in the slightly overcrowded cases and profusion of artifacts.

UNIVERSITY OF KANSAS MUSEUM OF NATURAL HISTORY

UNIVERSITY OF KANSAS, LAWRENCE, KS 66045.
Tel: (913) 864-4540.
Hours: Mon–Sat 8 am–5 pm, Sun and holidays 1:30–5 pm, closed Thanksgiving, Christmas, New Year's, July 4th.
Admission: Free.
Publications:

Barry L. Armstrong, James B. Murphy, *The Natural History of Mexican Rattlesnakes*. 1979, $6.

Joseph T. Collins, *Amphibians and Reptiles in Kansas*. 1974, $5.

Frank B. Cross, Joseph T. Collins, *Fishes in Kansas*. 1975, $6.

Henry S. Fitch, *The University of Kansas Natural History Reservation*. 1965, $2.40.

Reproductions: None.
Research: None.

In 1864 the Kansas legislature authorized the establishment of a "Cabinet of Natural History" at the University of Kansas. Today, this cabinet has actually grown into five museums: the Museum of Anthropology, the University Herbarium, the Museum of Invertebrate Paleontology, the Museum of Natural History, and the Snow Entomological Museum. Three of these museums are housed in one Romanesque-revival-type building on the campus.

The fifth floor of the building houses the North American Indian exhibits. One of the strangest of these is a rather scruffy-looking horse (with a few scars here and there) wearing a U.S. Cavalry saddle. This horse, ironically named Comanche, was the only U.S. Cavalry survivor of the battle of the Little Bighorn, popularly known as Custer's Last Stand. He was found by relief troops who arrived too late. Aside from this curious specimen, the Museum has substantial collections in the ethnography of the Plains Indians. On display are some extremely fine examples of beadwork, including intricately beaded moccasins, pipe bags, knife scabbards, and other objects. (It is interesting to note that virtually all the beads used by the Indians came from either Venice, Italy, or a few towns in what is now Czechoslovakia, the

worldwide makers of such beads.) Also in the Hall are exhibits showing the Greenland Eskimo, the buffalo (which were the lifeblood of the Plains Indians), Indian pottery and artwork.

Upstairs from the North American Indian exhibits is a sort of miniature zoo, with live snakes, bees, and fishes (all from Kansas, of course). Kansas birds (stuffed) are displayed as well, many in seasonal dioramas.

We cannot leave the Kansas Museum complex without directing you to the third floor, where the fossils and minerals are displayed. Kansas is a fine place to collect fossils (especially mammals) and some of the better ones are shown, including a saber-toothed cat and several giant mastodons. A reconstruction of a tar pit, with the now-extinct animals sinking to their doom, is another attraction. And finally, on the fourth floor is the impressive and magnificent "Panorama of North American Plants and Animals," said to be one of the largest exhibits of its kind in the world.

UNIVERSITY OF NEBRASKA STATE MUSEUM

LINCOLN, NB 68588. Tel: (402) 472-3779

Hours: Mon–Sat 8 am–5 pm, Sun 1:30–5 pm, closed Thanksgiving and Christmas.
Admission: Free; planetarium: $1.25 adults, $.50 children.
Publications: Three periodicals:

The scientific ones are a *Bulletin*, and a *Special Publication*. The popular one is *Museum Notes*.

Reproductions: Posters of some exhibits.
Research: Reference library open to scholars and graduate students. It is strong in geology and paleontology.

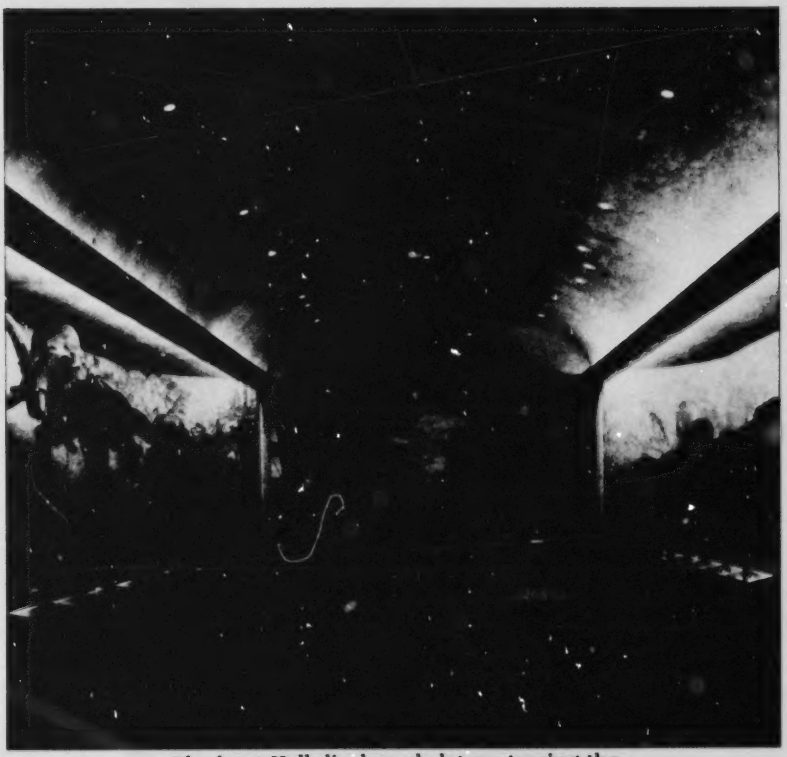
The University of Nebraska State Museum is a natural history museum in the classic sense. From its Hall of Elephants to "Ceres: The Plastic Woman," it encompasses all the disciplines of natural history. Its research collections are quite solid, two of which, parasitology and vertebrate paleontology, are internationally known.

The most impressive exhibit is the Hall of Elephants. The two long walls in this hall are lined with a parade of brown elephant skeletons tracing the probiscidians' 35-million-year evolution. They are all here, from the earliest forms to the modern African and Asian elephants. Nebraska is a good place to find extinct mammoths, and the hall includes one of Nebraska's finest, a 14-foot-high imperial mammoth discovered near North Platte in 1922. The great skeletons are placed against a background of a hypothetical Pleistocene landscape.

The Elephant Hall isn't restricted to Nebraska mammals, however. Dominating the center of the hall is a reconstruction of the world's largest known land mammal, taller than even the imperial mammoth. This ancient relative of the rhinoceros, baluchitherium, stands eighteen feet high at the shoulder, and roamed Central Asia some 18 million years ago. The animal was discovered by the Central Asiatic Expedition of Roy Chapman Andrews in the 1920s while exploring the wastes of Outer Mongolia. Standing next to it are two full-sized elephants—African and Indian—looking puny and somewhat insecure.

Nearly half the state of Nebraska is underlain by vast deposits of Pleistocene-Age sediments—dating from about 2 million years ago to the end of the last Ice Age. Much of the museum's superb collection of fossil mammals was dug up from these Pleistocene deposits, which are rich in fossils of what paleontologists call the "megafauna" that evolved during the last few million years in North America. Fossils in the museum representing this megafauna are, of course, the mammoths, but also five kinds of camels, different varieties of musk oxen, tapirs and peccaries (related to pigs) huge ground sloths, an extinct bison with a nine-foot horn-spread, and many others. Possibly the most astonishing of the large mammals was a Pleistocene beaver that grew to the size of a black bear.

A suite of habitat groups illustrates the flora and fauna of Nebraska, before the disruption of man. Some of these fine dioramas recapture the expansiveness and sweep of the pre-settlement Great Plains with its gently undulating landscape dotted with herds of animals.



Elephant Hall displays skeletons tracing the evolution of the species. The Baluchitherium, left, dwarfs the African and Indian elephants, right.

CHAPTER THREE

SCIENCE & TECHNOLOGY

by
VICTOR J. DANILOV

BUHL SCIENCE CENTER

ALLEGHENY SQUARE, PITTSBURGH, PA 15212. Tel: (412) 321-4302
Hours: Mon–Wed 1–5 pm, Thurs–Fri 1–5 pm and 6:30–9:30 pm, Sat 10:45 am–5 pm and 6:30–9:30 pm, Sun 1–9:30 pm.
Admission: $2.80 adults, $1.40 children; $6.50 family of up to six.
Publications: Free brochure.
Reproductions: Some postcards of subjects related to the exhibits.
Research: None.

The Buhl Planetarium and Institute of Popular Science in Pittsburgh recently underwent a name change—it is now called the Buhl Science Center. The move is part of a major updating and facelifting program planned for the museum. Opened in 1939, the Buhl center is known for its planetarium sky shows and roof-top public observatory. It also has exhibits and programs in such areas as space technology, industrial technology, biology, computers, health, and the physical sciences. Its Oudin-type Tesla coil is one of the largest early examples of this electrical apparatus still in active use. The museum also is known for its annual "Miniature Railroad and Village" display—portraying life in western Pennsylvania in the 1920s—which is shown during the Christmas season.

CALIFORNIA MUSEUM OF SCIENCE AND INDUSTRY

700 STATE DRIVE, LOS ANGELES, CA 90037. Tel: (213) [illegible]4-7400
Hours: Daily 10 am–5 pm, closed Thanksgiving, Christmas, and New Year's.
Admission: Free.
Publications: None.
Reproductions: None.
Research: None.

The California Museum of Science and Industry is in the midst of a major renovation and expansion program—partly in preparation for the 1984 Summer Olympics that will be held in the adjacent Coliseum and sports arena in Los Angeles.

Started as a state agricultural exhibit hall in 1912, the museum broadened its focus in 1951 to become a more comprehensive science and technology center. Since then, it has grown in size, scope, and attendance with state and private support.

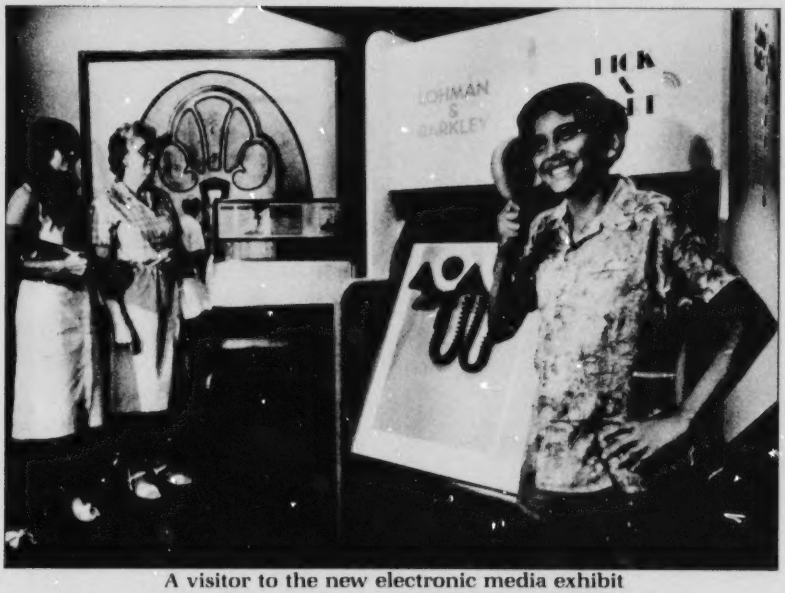
The California Museum of Science and Industry offers exhibits and programs in four separate buildings and attracts more than three million visitors each year. Major exhibits—many of them sponsored by companies, health organizations, and government agencies—are devoted to aviation, communications, energy, health, mathematics, metrics, minerals, natural resources, space, transportation, water use, and the animal industry.

A $36-million program has been launched to renovate and update the museum; add new exhibits in the finance and aerospace fields, and an IMAX theater, space garden and pedestrian mall; and build other state facilities—such as an Afro-American history and cultural museum and a multi-cultural center—in Exposition Park.

A new aerospace building is scheduled to be completed before the 1984 Olympics to house new exhibits and the present space units in a remodeled Armory. It will trace the history of space flight, explain space technology, and contain replicas and actual space rockets, satellites, and other space equipment. In addition, plans call for an outdoor space garden.

Energy is covered in three exhibits. The "Hall of Electricity" explores the story of electricity from early theories to futuristic power systems. It contains pushbutton experiments in static electricity, magnetism, and current electricity. Another exhibit examines fusion as an energy source. The "Energy" exhibit takes a broader look—dealing with the sun as a source of energy, laws of energy, energy conversion, attempts to harness energy, and the role of natural gas.

Transportation is the focal point of "The Turning Wheel" in a broad-based transport exhibit. The evolution of the automobile, principles of mechanical science, and the impact of the motor vehicle on society are shown. Another transportation exhibit contains the largest O-gauge miniature railway systems, which also explains the relationship. To commerce and daily life trains, buses, trucks, cars, and planes pass 10 typical geographic and industrial areas of California.



A visitor to the new electronic media exhibit listens to radio duos, an exploration of advertising, television, recording and animation.

In the natural resources area, exhibits are concerned with minerals, water, and forests. The "Mineral Hall" has exhibit units on California minerals, lapidary work, black light with fluorescent rocks, radioactivity, and the use of minerals. California's water supply—its origin, storage, distribution, and importance—is the theme of another exhibit on natural resources. A third exhibit describes the geography, redwoods, forest industry, and wildlife of California.

"Industry Hall" chronicles the state's industrial expansion and shows the fundamentals of manufacturing and materials processing. Among the highlights are a model steel mill as well as passenger and cargo ship models. The "Marine Room" has dioramas of the Los Angeles and San Francisco harbors.

In the communications exhibit, many of the latest developments in telecommunications and related fields are explained. Among the exhibit units are those concerned with lasers, microwave communications, and communications satellites. An interactive electronic media exhibit looks at advertising, television, recording, and animation.

One of the most popular exhibits continues to be the "Mathematica" hall designed by Charles and Ray Eames and presented by IBM. It features a history wall and participatory units on celestial mechanics, topology, multiplication, geometry, and probability.

The "Hall of Health" is housed in a 10,000-square-foot adjacent building. It explains the workings of the body from the smallest blood cell to the great

organ systems. Exhibit units deal with birth and reproduction, the nervous system, drugs and narcotics, the senses, and the circulatory system. A dental exhibit also can be seen in the main building.

In educational programming, the California Museum of Science and Industry offers a range of classes, workshops, demonstrations, lectures, summer programs, traveling exhibits, science plays, films, and special projects.

With the capital, exhibit, and program improvements under way, the California Museum of Science and Industry will become an even greater magnet for those interested in science and technology.

CENTER OF SCIENCE AND INDUSTRY

280 E. BROAD STREET, COLUMBUS, OH 43215. Tel: (614) 228-6361
Hours: Mon–Sat 10 am–5 pm, Sun 1–5:30 pm, closed holidays.
Admission: $3.50 adults, $2 students and senior citizens, $10 families.
Publications: Free brochure.
Reproductions: Postcards and slides of exhibits; posters of special exhibitions.
Research: None.

When the Center of Science and Industry took over the old building of the Franklin County Historical Society in Columbus in 1964, it installed a new glass facade, a renovated interior, and a different direction. COSI, as the science center is known, changed the focus from history to science and technology and the emphasis shifted from the historic to the contemporary.

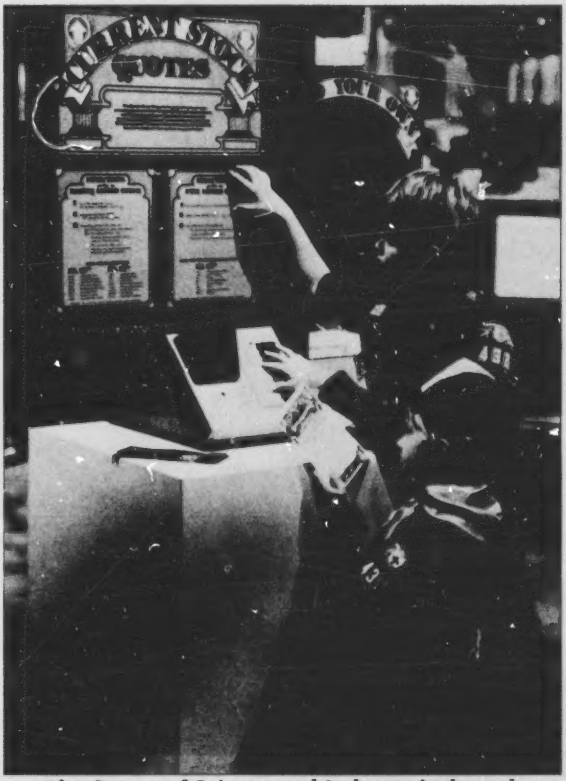
Today, the Center of Science and Industry is the showcase of science and technology in Columbus, serving over 300,000 annual visitors with dynamic exhibits, demonstrations, and educational programs.

COSI seeks to explain science and technology through interaction, observation, and deduction. "Through science," its literature states, "one can better understand the world we live in, discover new worlds, and even create new worlds. Sparking curiosities and motivating further exploration and understanding of the world around us in the underlying theme that races through the veins of the Center of Science and Industry."

The visitor can explore the depths of the Jeffrey Coal Mine, walk down the Durell Street of Yesteryear, meet the U.S. Presidents, blast-off in a space capsule, journey through the universe in the Battelle Planetarium, see the iris in the eye open and close, and shout into an echo tube.

Upon entering the museum, visitors are treated to a space and transportation exhibit in the solar front of the building. Among the sights are a miniature two-man submarine, a Model-T Ford, an old fire engine, a Cessna airplane, a NASA space trainer, a hot air balloon, and a replica of the Wright brothers' plane, the Mariner satellite, and Gemini and Apollo space capsules.

The first of four floors of exhibits contains a caboose, an amateur radio station, and a physical science mall, as well as exhibits on paint, steel, communications, kitchens, sound, heat conductors, perception, electronics, and other fields.



The Center of Science and Industry is the only museum in the country to have an on-line stock ticker with current New York Stock Exchange quotations.

Among the topics covered in the second floor exhibits are chemistry, environment, oceanography, metric system, glass, plastics, agriculture, crime detection, and energy. The Battelle Planetarium, the "Talking Car," a weather station, an environmental theater, the U.S. Presidents' Hall, and "Street of Yesteryear" (featuring a Nickelodeon theater, antique dolls and lamps, history crafts area, and yesterday's headlines) are also presented.

Health exhibits dominate the third floor. There are exhibits on birth, nutrition, heart, teeth, hearing, sight, anesthesiology, anatomy, veterinary medicine, electric eels, and beekeeping. A "Transparent Talking Woman," live demonstrations on life sciences and drugs, and the "Time Train" exhibit also can be found there. The latter is an 820-square-foot model layout featuring moving railroads, canal boats, and villages, among other things depicting Ohio transportation from the 1750s to present high-speed trains.

In addition, COSI has a walk-through coal mine, goblet and elephant

collections, a rock exhibit, historical vending machines, and a greenhouse on the ground floor, and Foucault pendulum, mobius strip, Liberty Bell, and museum history exhibits in the lobby.

The Center of Science and Industry designs and fabricates most of its exhibits internally, and even produces units for other museums. Its most current project is the development of "Kidspace," a participatory exhibit for children two to seven years of age.

COSI has regularly scheduled science demonstrations in the life and physical sciences, and presents a "Super Summer Science Show" with highly animated and articulate demonstrators who captivate audiences with their antics.

The science center also has an extensive educational program that includes curriculum-oriented school programming; workshops for students, adults, and teachers; and special and overnight programs for Scouts.

Through its innovative and expanding efforts, the Center of Science and Industry has become an exciting learning center and a focal point for informal science activities in the state.

DES MOINES CENTER OF SCIENCE AND INDUSTRY

4500 GRAND AVENUE, GREENWOOD-ASHWORTH PARK,
DES MOINES, IA 50312. Tel: (515) 274-4138
Hours: Mon–Sat 10 am–5 pm, Sun 1–5 pm.
Admission: $2 adults, $1 children 12 and under and senior citizens, free to children under 5.
Publications: Free folder.
Reproductions: Postcard of the building.
Research: None.

The Des Moines Center of Science and Industry seeks to stimulate interest and knowledge about the sciences and technology, particularly in the areas of astronomy, computer science, physical sciences, health, and natural sciences. Its offerings include 20 computer terminals, a large miniature railroad layout, a live animal facility, a discovery room, planetarium and laser shows, a chick hatchery, 26 live demonstration programs, and exhibits on energy, health, weather, probability, and other fields. The education program includes preschool classes, a self-guided nature trail, an overnight "Camp In" for organized youth groups, and an outreach program that takes science demonstrations into area schools, hospitals and retirement homes.

DETROIT SCIENCE CENTER

5020 JOHN R STREET, DETROIT. MI 48202. Tel: (313) 833-1892
Hours: Tues–Fri 9 am–4 pm, Sat 10 am–8:30 pm, Sun 12 noon–8:30 pm, closed Mon, Thanksgiving, Christmas, and New Year's.
Admission: $3 general, $.75 children 4–5, $2 senior citizens.
Publications: Free brochure.
Reproductions: Some postcards of subjects related to the exhibitions.
Research: None.

Founded as an experimental storefront museum, the Detroit Science Center now occupies a modern building in Detroit's cultural center. It is the beginning of a multi-building complex planned for the future on an eight-acre site. More than 50 participatory exhibits can be found in the exhibit hall, which has a demonstration theater for live programs on science topics ranging from chemistry to lasers. The principal attraction is the Omnimax/planetarium theater, with a 67-foot tilted dome screen that wraps around the audience. Its 70-mm projection system covers virtually the entire dome with a single image, giving viewers the illusion of being in the picture.

THE EXPLORATORIUM

3601 LYON STREET, SAN FRANCISCO, CA 94123. Tel: (415) 563-7337

Hours: Wed–Fri 1–5 pm, Wed 7–9:30 pm, Sat and Sun 12 noon–5 pm, closed Mon and Tues.

Admission: $2.50 adults, $1.25 senior citizens and groups; free to children 18 and under.

Publications: Innovative books and magazines, describing exhibits and providing scientific background. The "Cookbooks" actually show how to build exhibits.

Raymond Bruman, *Cookbook 1*. 1976, $60.

K. C. Cole, *Facets of Light: Colors, Images and Things that Glow in the Dark*. 1980, $8.50.

——*Vision: In the Eye of the Beholder*. 1979, $5.

Ron Hipschman, *Cookbook 2*. 1980, $40.

Thomas Humphrey and Marsha Tanner, *Sound, Hearing, Resonance*. 1977, $3.50.

The Exploratorium. Published quarterly, $10 per year.

Reproductions: Posters and postcards of major exhibits, including optical illusions and one heat-sensitive postcard. Small-scale replicas of some exhibits are available.

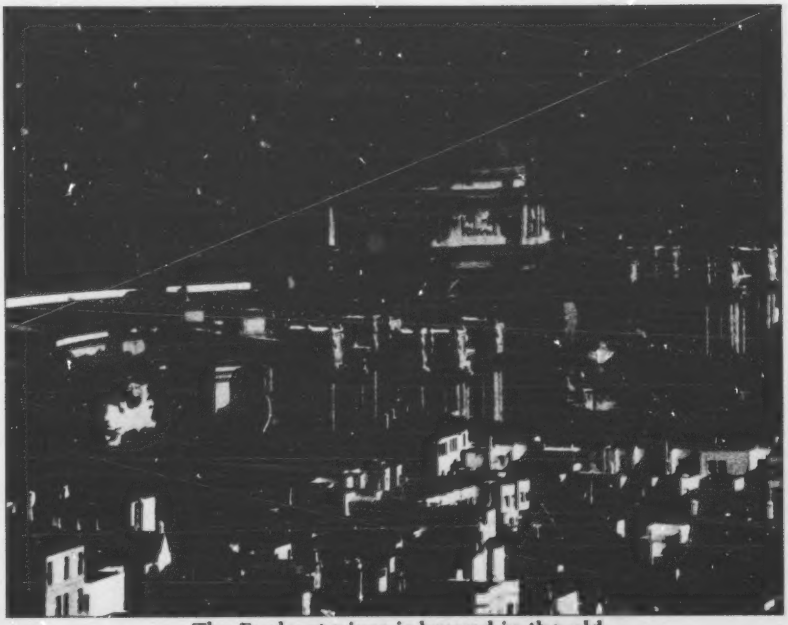
Research: Library open to staff only.

The Exploratorium in San Francisco is one man's dream. In the late 1960s, a University of Colorado physics professor began talking and writing about the need for a new type of science museum concerned largely with perception, that would have aesthetic appeal as well as pedagogical purpose, and that would offer opportunities for casual scientific sightseeing.

In 1969, Frank Oppenheimer saw his dream become a reality when the Exploratorium opened in the old Palace of Fine Arts building, a cavernous hangar-like relic from the 1915 Panama-Pacific International Exhibition.

"There is an increasing need to develop public understanding of science and technology," stated Oppenheimer. "The fruits of science and the products of technology continue to shape the nature of our society and to influence events which have a worldwide significance. Yet the gulf between the daily lives and experience of most people and the complexity of science and technology is widening. . . ."

He proposed an informal and inviting learning environment consisting of a range of participatory exhibit units having human sensory perception as the focal point. He then set out to design and build the exhibits—many of which looked like elaborate science fair projects or Rube Goldberg creations. But they worked—and they began to attract the public to this unusual



The Exploratorium is housed in the old Palace of Fine Arts building, a mock Greek temple complete with frieze and ruined columns.

science museum with virtually no artifiacts, cement floors, crude but effective exhibits, a trailer for an office and an exposed workshop that became an exhibit itself.

This was the beginning of the Exploratorium—a contemporary science center that calls itself "an artfully conceived science museum dedicated to discovery—a place to go sightseeing among the world's natural and scientific phenomena." Others have called it "the ultimate in participatory science" and "the best science museum in the world."

Each year, about 500,000 people push, pull, open, look through, listen to and talk at some 500 interactive exhibits designed for exploration, investigation, and delight. They come in all ages, and with a variety of backgrounds—from illiterates to Ph.D.s. The visitors have fun as they learn about the interconnecting physical principles of the world around them. They are treated to exciting exhibits based on light, sound, vision, hearing, touch, electricity, motion, mathematics, patterns, nerves, muscles, and plant and animal behavior.

The public is invited to: "Step into a Distorted Room that has no right angles. Measure your heartbeat. Transform the action of your legs into the energy needed to turn on a light. Experience momentum building with a spin on the Momentum Machine. Witness the process by which museum

staff in the carpentry, machine, electronics, and graphics shops continually create new exhibits."

Taking human perception as its starting point, the Exploratorium enables its visitors to confront the fundamental forces of nature, the major accomplishments of science, and the latest developments in technology. The emphasis is on self-discovery, with a minimum of label information and a maximum of opportunity to play with and learn from the exhibits.

If you need help, the science center has high school-age "Explainers" stationed throughout the building. They assist visitors, explain exhibits, and help set up the experiments and exhibits. About seventy boys and girls work as paid Explainers during a typical year. The goal of the program is to encourage them to further their education—not necessarily to make them scientists.

"The Exploratorium was conceived," according to its Statement of Broad Purposes, "to communicate a conviction that nature and people can be both understandable and full of newly discovered magic. It, therefore, provides experimental opportunities for learning that are difficult, if not impossible to achieve through school classrooms, books, or television programs. The Exploratorium is not a substitute for other vehicles for learning, but it does provide a fascination with learning that cannot be found elsewhere and which facilitates traditional teaching at all levels."

Part of this fascination can be attributed to ingenious exhibit techniques. The "Sun Painting," for example, immediately draws you to it. It is a light sculpture made of prisms and mirrors refracting the sunlight from a rooftop collection which follows the sun's path across the sky. As you approach the exhibit, your movements alter the prism position, block the sun rays, and create a different sun painting.

The "Discernibility" exhibit combines technology with perception by allowing electronic manipulation of your own television image. Sitting before a video screen that projects your face, you can distort and change the image by touching heat-sensitive buttons on the control console.

Few Exploratorium exhibits are more exciting than the Tactile Gallery. You leave visual images for the world of touch by entering the total darkness of a geodesic dome. You touch burlap, rope, metal, wood, and rubber as you make your way through a tunnel; experience the cold of refrigerated panels and the softness of chicken feed; and crawl through simulated cobwebs and a punching bag forest.

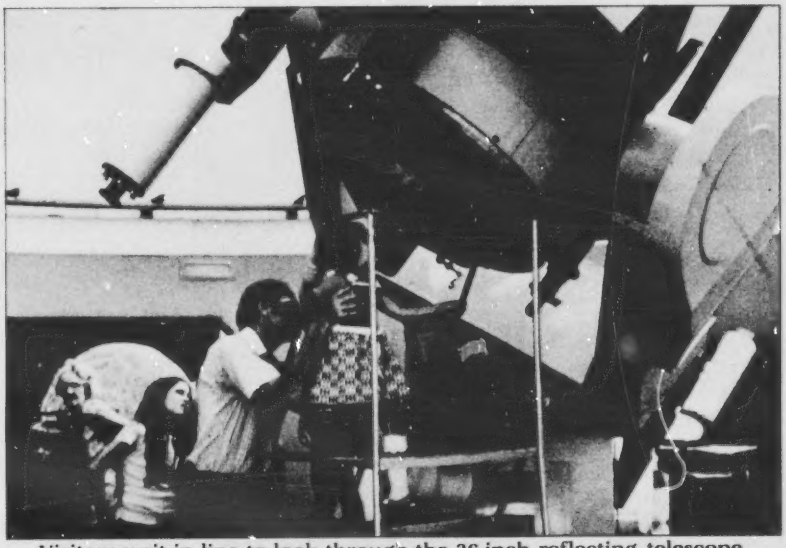
Among the other exhibits are: "Build an Arch," where visitors construct a chain-like arch by lining up blocks in a certain order and then lifting it into a vertical position; "Enchanted Tree," which responds to sound with blinking lights; "Everyone Is You and Me," a demonstration of the properties of reflection using partially reflecting mirrors and independently controlled light sources; and "Links," in which a visitor sits before a video monitor attached to a microcomputer and then types out a phrase or word to which the computer responds. In about 75 percent of the cases, the resulting combinations make sense. Sometimes the effect is brilliant, but often it is also humorous.

Many of the imaginative exhibit ideas come from artists-in-residence at the Exploratorium. Since 1974, the science center has commissioned four to six artists annually to produce works of art for the Exploratorium. Interspersed with the more didactic exhibits on the museum floor, these artistic works make subtle connections between nature and culture, as well as between science and art.

The educational program includes classes for children and adults and a school laboratory program. The Exploratorium is also known for its publications and residency program. The *Cookbook* series contains plans for numerous basic exhibits; the exhibit catalogs explain commonly experienced phenomena in such fields as light, color, sound, and vision; and idea and recipe sheets based on the laboratory curriculum help teachers with experiments and other assignments.

FERNBANK SCIENCE CENTER

156 HEATON PARK DRIVE, NE, ATLANTA, GA 30307.
Tel: (404) 378-4311
Hours: Mon and Sat 8:30 am–5 pm, Tues–Fri 8:30 am–10 pm, Sun 1:30 pm–5 pm.
Admission: Free, except for planetarium.
Publications: Free brochure.
Reproductions: Some postcards of subjects related to the exhibitions.
Research: Reference library open to public. It is strong in astronomy, horticulture, and ecology.



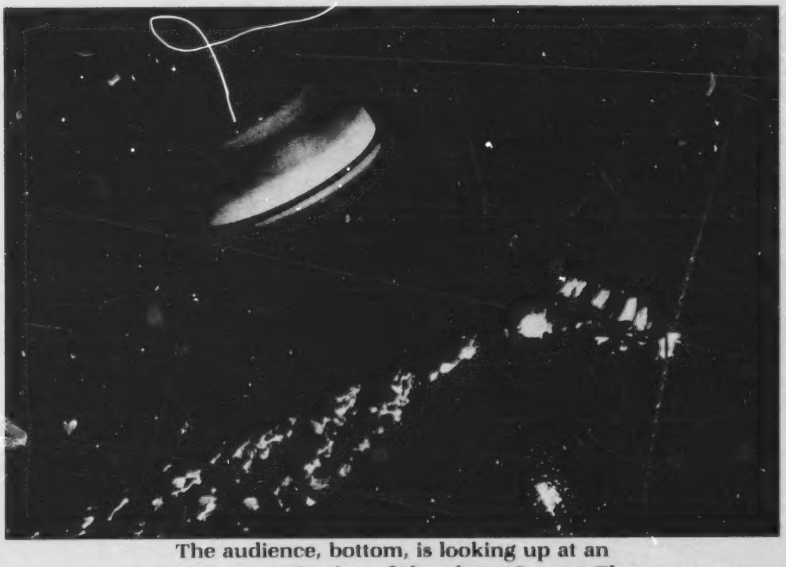
Visitors wait in line to look through the 36-inch reflecting telescope. It is usually pointed at the Moon, planets, nebulae or star clusters, though it is used to observe a wide range of astronomical phenomena.

Fernbank Science Center had its origin as a forest and living laboratory and later became a more comprehensive science education center operated by the DeKalb County Board of Education. Located on the outskirts of Atlanta, the science center opened its well-equipped facilities in 1967 with the help of U.S. Office of Education Title III funds. It is an integral part of the county school system, providing exhibit, classroom and laboratory experiences as part of the curriculum. In addition to the 65-acre forest and exhibits, Fernbank has a planetarium, observatory, embryology classroom, electron microscopy laboratory (as well as radiation and meteorological), reference library, greenhouse, and traveling exhibits.

REUBEN H. FLEET SPACE THEATER AND SCIENCE CENTER

BALBOA PARK, PO BOX 33303, SAN DIEGO, CA 92103
Tel: (619) 238-1233

Hours: Mid-Sept through mid-June: Mon–Thurs 9:45 am–5 pm and 7–9:30 pm, Fri 9:45 am–5 pm and 7–10:30 pm, Sat 9:45 am–10:30 pm, Sun 9:45 am–9:30 pm. Summer months: Sun–Thurs 9:45 am–9:30 pm, Fri–Sat 9:45 am–10:30 pm.
Admission: $4 adults, $2.50 senior citizens, $2.25 children 5–15, free to children under 5.
Publications: Free brochure.
Reproductions: Postcards and posters of the museum and some exhibits.
Research: Reference library open to members by appointment.



The audience, bottom, is looking up at an enormous projection of the planet Saturn. The planetarium controls are in the foreground.

The Fleet Space Theater and Science Center in San Diego is known more for its Omnimax theater than its exhibits. The first theater/planetarium of its type, it has served as the prototype for similar facilities elsewhere. The theater has a hemispheric screen that is 76 feet in diameter, inclined 25 degrees to the horizontal, and has an image area ten times that of a standard movie theater. In the center of the theater is a star field projector—a four-foot ball with 10,000 lenses—and the 70-mm Omnimax projection equipment. Big screen and mixed media productions shows, such as "Hail Columbia!" and "Cosmic Quest," are presented in the theater. In the exhibit hall, visitors can operate a cloud chamber, a heart oscilloscope, a wave tank, an ergometer, a light mixing booth, and a Navy submarine periscope.

HENRY FORD MUSEUM AND GREENFIELD VILLAGE

20900 OAKWOOD BOULEVARD, DEARBORN, MI 41821.
Tel: (313) 271-1620

Hours: Daily 9 am–5 pm, closed Thanksgiving, Christmas, and New Year's.
Admission: $8 adults, $7 senior citizens, $4 children 6–12, free to children under 6 and members.
Publications: Books and brochures include:

Geoffrey C. Upward, *A Home for our Heritage: The Building and Growth of Greenfield Village and Henry Ford Museum*. 1979, $9.95.

Fannia Weingartner, *Henry Ford Museum and Greenfield Village: A Pictorial Souvenir*. 1983, $3.95.

Reproductions: Posters, prints, postcards of the museum and village.
Research: Archive and research library open to qualified researchers by appointment.

The Henry Ford Museum and its adjacent outdoor historical museum, Greenfield Village, were opened with great fanfare in Dearborn in 1929. They were dedicated to preserving America's heritage, and reflected the collecting philosophy of their founder, Henry Ford, who believed in saving virtually everything.

As a result, the Henry Ford Museum is a 14-acre storehouse of things from the past—mostly of a mechanical, agricultural, and craft nature. It consists of three parts under one giant roof and an entrance building that is an exact replica of Independence Hall. With Greenfield Village, it is said to be the world's largest indoor-outdoor museum complex.

The three sections deal with American decorative arts, the mechanical arts, and craft shops from the eighteenth and nineteenth century. As explained in its guidebook, the Museum is "a general museum of American history housed in the most American of buildings. Here, with collections matchless in both depth and scope, is the story of America's growth, its inventive genius, the development of its tastes and modes. Any one section of this Museum, be it agriculture, power, transportation, communications or furniture, is a fascinating history of the American people—their yearnings, their explorations, their accomplishments."

Among the some 200 automobiles in the collection are the 1922 Detroit Electric, left, the 1930 Ford Phaeton, right, and the 1925 aluminum Pierce-Arrow, foreground.

The Henry Ford Museum is known for its massive collections of automobiles, power machinery, metalwork, locomotives, ceramics, agricultural equipment, airplanes, glassware, bicycles, furniture, household utensils, horse-drawn vehicles, sewing machines, typewriters, communications equipment, textiles, musical instruments, and many other objects. They present a panorama of American life over the last 350 years.

Once presented row after row without much explanation, the displays have been undergoing a facelifting. In an effort to make them more meaningful to visitors, museum officials have rearranged and added interpretive elements to many of the exhibit areas. But it is the historic objects that are mind-boggling.

The Henry Ford Museum has more than 200 old cars, spanning the automobile revolution since the turn of the century. They include Ford's first car; the two-cylinder "Quadricycle" of 1896; Barney Oldfield's famous "999" racer; the one-cylinder 1903 Cadillac Runabout; the 1909 Sears Motor Buggy that sold for $325 through the catalog; the Stanley Steamer; the 1907 Rolls Royce Silver Ghost; and the 1914 Detroit Electric.

Covered wagons, sleighs, boats, fire engines, carriages, hearses, trucks, bicycles, motorcycles, railway cars, locomotives, and planes are among the other vehicles of transportation on display. There is a ten-person, 23-foot-long bicycle that could not turn a corner; the tiny DeWitt Clinton locomo-

tive of 1831; the monstrous 600-ton Allegheny coal-burning locomotive; a Bleriot monoplane of 1909; the 1926 Fokker and the 1928 Ford Trimotor that Adm. Richard E. Byrd flew over the North and South Poles, respectively; as well as the first practical helicopter, the Vought-Sikorsky VS-300.

The museum also houses early steam engines, dynamos, and generators; woodworking and metalworking machines; plows, threshers, harvesters, and other agricultural implements; printing presses; cameras, phonographs, and telephones; pistols, muskets, and rifles; and other machines and innovations of bygone eras.

Everything from cigar store Indians to player pianos can be found in the exhibit halls. There are toilet accessories such as wig stands, boot jacks, and perfume bottles; rocking horses, china-headed dolls, puppets, and carved pull toys of the 1700s and 1800s; barber chairs and shaving mugs; wooden bathtubs, hip baths, and oval foot baths; and cheese presses, dough boxes, apple mills, and other kitchen equipment.

Some of the finest examples of American cabinet making and furniture of successive styles can be found in the museum's decorative arts galleries. Among the other sights in the galleries are early musical instruments; Simon and Aaron Willard grandfather clocks; Paul Revere and Paul Storr silverware; China-Trade porcelain; silver coffee pots, teapots, and tankards; glassware, ceramics, and pewterware; textiles; and portraits and sculpture going back to Colonial days.

One of the featured attractions of the Henry Ford Museum is the "Street of Early American Shops," which has about a dozen shops which preserve the tools and handwork of preindustrial artisans. They include a millinery and fancy goods store, candle shop, toy shop, gun and locksmith shop, barber shop, and leather shop.

The Museum has a 60,000-volume research library of seventeenth-, eighteenth-, and nineteenth-century books on American history including the mechanical and decorative arts. In addition, there are 14-million documents and 450,000 photographic negatives of twentieth-century America in the archives.

An extensive educational program is offered by the Museum. In addition to classes and workshops, there are a number of special events each year, such as the Midwest Antiques Forum, Autumn Harvest Weekend, and the Christmas season program during which the buildings are decorated in the same manner as they would have been in the past.

It is difficult to separate the Henry Ford Museum from Greenfield Village—which together constitute the Edison Institute. The village is a 260-acre outdoor museum arrayed around a village green. It has some 100 historic structures, including the original Edison Laboratory and Menlo Park Compound, homes of famous Americans, operating craft shops, and nineteenth-century American industrial plants.

A stroll down the shady lanes of Greenfield Village is like a walk through a large cross-section of American history. Among the buildings moved to the village are the Wright Cycle Shop in which Orville and Wilbur Wright designed and fabricated the first flying machine; the original Logan County

Courthouse in which Abe Lincoln practiced law in frontier Illinois; the one-room log cabin that was the Pennsylvania birthplace of William Holmes McGuffey, whose "McGuffey's Readers" were used in the first six elementary grades in early America; the elaborate nineteenth-century dwelling in which Noah Webster compiled his monumental dictionary of the English language; the Pittsburgh residence of composer Stephen Foster; the home of an indentured servant in the Puritan settlement of 1638; and the summer retreat of Charles Steinmetz, the electrical wizard and mathematician.

In addition, Greenfield Village houses an entertainment center from the turn-of-the-century, called Suwanee Park. Two steam locomotives also take trainloads of visitors through the village, while a little paddle-wheel steamer cruises on a lagoon in the complex.

FRANKLIN INSTITUTE SCIENCE MUSEUM

20TH STREET AND BENJAMIN FRANKLIN PARKWAY,
PHILADELPHIA, PA 19103. Tel: (215) 564-3375.

Hours: Mon–Sat 10 am–5 pm, Sun 12 noon–5 pm, closed Memorial Day, Independence Day, Labor Day, Thanksgiving, Christmas Eve and Day, and New Year's.
Admission: $3.50 adults, $3 students 12 through college, $2.50 children 4 to 11, $2.00 senior citizens, free to children under 4.
Publications: Brochure.
Reproductions: Postcards of the institute and related subjects.
Research: Library open free to members and staff; $25 per day to others by appointment. It is strong in organic and physical sciences.

The Franklin Institute Science Museum opened in Philadelphia in 1934, but its lineage goes back to 1824 when Samuel Vaughan Merrick and William H. Keating founded "The Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts."

Dedicated to Benjamin Franklin in honor of his many useful inventions, the Franklin Institute originally was located in the County Court House, now known as the Independence Hall Buildings. The institute offered exhibitions and classes and established a Committee on Inventions (precursor to the prestigious Franklin Institute Medals) during its first year.

The Franklin Institute's pioneering efforts had widespread impact in the nineteenth century. In addition to lectures, it started Franklin High School with its innovative curriculum—combining theoretical and practical science with liberal arts courses—in 1826. This approach later was adopted by Philadelphia's public school system.

From 1825 to 1934, the Franklin Institute was located in what later became the home of the Atwater Kent Museum. In 1930, Poor Richard's Club and the institute conducted a public subscription campaign for funds for a science museum and memorial to Benjamin Franklin. About $5,100,000 was raised in twelve days to house the newly founded Franklin Institute Science Museum and Planetarium at its present location along tree-lined Benjamin Franklin Parkway. Samuel S. Fels provided the funds for the planetarium bearing his name, which is the second oldest planetarium in the nation.

The museum opened on January 1, 1934—about six months after the nation's first successful contemporary science and technology museum began operations in Chicago. But the impressive Benjamin Franklin Memorial, located in the English Renaissance building, was not completed until 1938.

Octagonal in shape, the memorial was inspired by the Pantheon in Rome and designed by architect John T. Windrim. It is 82 feet in length, width, and height and is made of rare marbles from Portugal, Italy, and France. Dominating the hall is a twenty-foot statue of Franklin, sculpted by James Earle Fraser, in white Seravezza marble. It became the nation's official memorial to Benjamin Franklin in the 1976 bicentennial year.

The Franklin Institute is a tripartite organization that includes the museum and planetarium; the Bartol Research Foundation located on the campus of the University of Delaware; and the Franklin Research Center, which is one of the country's leading nonprofit research institutes. The Institute contains a library with 300,000 volumes and a flow of some 4,000 periodicals in nearly every language in the world.

The Franklin Institute Science Museum is the best known of the three parts of the Institution. Because of its innovative exhibits and educational programs, the museum has achieved great popularity.

Since its founding, the Museum has encouraged visitor participation. For example, it is possible to walk through a giant human heart, play the world's largest pinball machine, move a 500-pound block with the help of pulleys and ride a 350-ton locomotive (a part of the museum was built around it).

The Franklin Institute Science Museum has been a leader in developing new exhibit techniques. It pioneered the use of computer exhibitry. The computer graphics on flight and flying in the Aviation Hall illustrate the museum's computer talents. The hall also contains a Wright B Flyer; a replica of the Wright brothers' workshop; an Air Force T-33 jet trainer that visitors can climb into; and a Boeing 707 jetliner that the public can tour.

For more down-to-earth travel, the museum has a collection of antique bicycles that includes several high-wheelers and children's bicycles dating from 1818 to 1902. A new transportation exhibit is "Shipbuilding on the Delaware," which traces the technological development of the shipbuilding industry in the Philadelphia area. It makes use of participatory devices, videotapes, artifacts, computers, a puppet theater, and a 46-foot towing tank with a wavemaker to tell the story covering 300 years.

Exhibits at the Franklin also explain such basic and applied science areas as physics, electricity, printing and papermaking, light, timekeeping, mathematics, fire fighting, computers, and illusions. In addition, the museum has an operating amateur radio station, an air monitoring station, the nation's largest public observatory, Fels Planetarium (with sky and multimedia shows), and an outdoor "Science Park" which has over forty exhibits involving water, the sun, measurement, and physics.

Off the premises, the Museum operates the "Museum-on-the-Mall" science exhibit at the Gallery shopping mall in downtown Philadelphia. Traveling

This clear globe memorably depicts the major constellations in the northern and southern hemispheres.

science exhibits tour other shopping plazas in the area in an effort to bring science to the public.

The museum's education program includes live science demonstrations, lectures, courses for children and adults, lessons for school classes, discovery workshops for young children, traveling science shows, and programs for academically talented students and teachers.

Science shows are presented in the lecture hall on such topics as chemistry, light and sight, and physics in sports. Similar traveling shows are made available to schools. They cover such fields as temperature, chemistry, energy transformation, sound and waves, light and color, electricity, as well as machines and air and space flight.

The "Discovery Theater" program is for young children. In an informal setting, youngsters learn about states of matter, simple machines, air, and concepts of force, friction, and gravity. The "Discovery Workshops" are participatory courses for children and adults, while the science lessons, lasting about fifty minutes, are offered to visiting school groups. They are presented in classrooms, but may include guided visits to exhibit areas.

Unlike many science centers, the Franklin Institute Science Museum also has research programs—one based on the museum's historical collections and archives and another dealing with exhibit effectiveness research and evaluation.

HAGLEY MUSEUM

RT. 141 NEAR RT. 100, PO BOX 3630,
GREENVILLE-WILMINGTON, DE 19807. Tel: (302) 658-2400.
Hours: Tues–Sat 9:30 am–4:30 pm, Sunday 1 pm–5 pm, closed Mon.
Admission: $2.50 adults, $2 students and senior citizens, free to children under 14.
Publications: Free brochure and:
The Hagley Museum Guide. 1976, $2.
Reproductions: Postcards of the building.
Research: Library open to public.

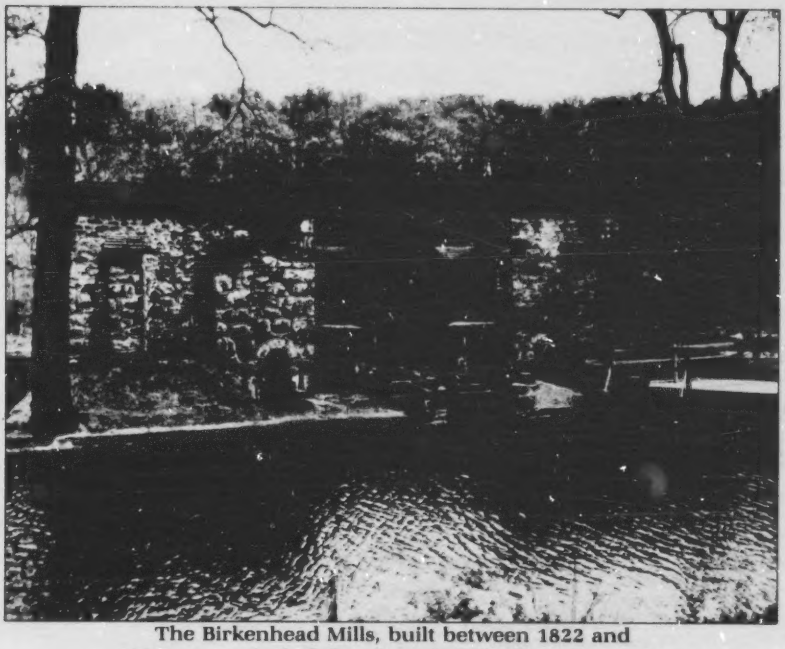
Located along Brandywine Creek near Wilmington, the Hagley Museum is a 226-acre outdoor museum that seeks to preserve and interpret a historic industrial site while relating it to the broader story of the nation's industrial history.

The museum is operated by the Eleutherian Mills-Hagley Foundation, established in 1952 on the 150th anniversary of the black powder company founded on the banks of the river by Eleuthère Irénée du Pont in 1802. The young French immigrant named the site "Eleutherian Mills," an adaptation of his name. A decade later, du Pont acquired adjoining lands, which were called Hagley. The foundation derives its name from these two former industrial properties.

When the foundation was created, various members of the du Pont family donated land that included the original E. I. du Pont black powder works, the site of explosives manufacturing from 1802 until the yards were closed in 1921. With the property came a number of other structures, including abandoned stone mills and other industrial facilities. In subsequent gifts, the foundation received the Eleutherian Mills Residence, built in 1803, and other lands.

The foundation originally was endowed by the du Pont Company, with additional funding coming from the Longwood Foundation in 1961 when the Longwood Library was merged with the Hagley Museum library—becoming a major source of business, economic, and technological history reference materials.

The Eleutherian Mills-Hagley Foundation began its work with the opening of the Hagley Museum in 1957. Today, its activities include a specialized research library, a graduate program (in conjunction with the University of



The Birkenhead Mills, built between 1822 and 1824, are typical of the more than 20 stone buildings from the original Du Pont powder mills.

Delaware) for the training of historians and museum professionals, and a publications program on industrial and technological history.

The museum contains industrial and domestic buildings that show many aspects of life and work in a nineteenth-century industrial complex—thereby presenting an important chapter in the story of the growth of industrial America.

The main museum building was built in 1814 as a textile mill. Two floors of exhibits and dioramas depict development of industry along Brandywine Creek and throughout the nation. Temporary exhibits are featured on the third floor.

The museum's initial emphasis on industrial processes, power, and black powder manufacturing has evolved over time. Increasingly, restorations and interpretation are highlighting the social and human history aspects of Hagley's early days. Continuing research has provided a wealth of information on the role of the powder workers and their families, to supplement the colorful history of the owner-managers who founded a dynasty.

A walk along the picturesque river through the lower powder yards gives some sense of the power contained in the water of the Brandywine. The Brandywine—which drops 124 feet in five miles before reaching the Delaware River—was the major reason du Pont settled in the area in 1801.

Four dams still exist on the property. They are reminders of the potential of this small stream. In the past, the dams channeled water into millraces and flumes which powered the scores of wheels and turbines used to produce black powder.

Along the road is the reconstructed New Century Power House, which originally was constructed as the nineteenth century drew to a close. The power house, which provided power for the mills until they closed in 1921, is an operating hydroelectric plant which generates about 80 percent of Hagley's electrical energy needs.

Next is the Millwright Shop, which was used to repair and construct powder yard machinery. Today, the building houses a fully operable machine shop and dioramas depicting the black powder-making process. A machinist gives demonstrations using authentic machine tools from the 1800s.

At this point, visitors have the choice of catching the jitney bus to the upper property, or hiking up the most recently restored area of the lower property, known as Blacksmith Hill. The hill was the entrance to the yards and the way to the Blacksmith Shop during the plant's heyday.

The path also goes by the Gibbons House and the restored Belin House and Carriage House. The former was the home of John Gibbons and his family. Gibbons came from Ireland in 1839 and worked in the powder yards for $17.50 per month until 1850 when his pay was raised to $24. He then became a foreman—a position he held until his death in 1885. The Belin House takes its name from the fact that three of the company's early bookkeepers—August Belin, his son, and grandson—occupied the house with their families from 1825 to 1870.

Nearby is the 1817 Brandywine Manufacturers' Sunday School, where 150 children studied reading, writing, religion, spelling, and ciphering every Sunday morning. Interpreters allow students in school groups to write with a quill pen, and actually give them a math lesson in the old schoolhouse.

A wide array of horse-drawn vehicles can be found in the barn, constructed in 1802–03. They include a Conestoga wagon dating back to 1823 and an elaborate Rockaway coach like the one used by Francis Gurney du Pont to make his daily inspection tour of the powder mills in the 1890s. A weathervane collection in the Barn contains fish, sheep, cow, horse, grasshopper, and bird designs.

The Eleutherian Mill Residence that was built by du Pont is a Georgian-style structure reflecting the tastes of five generations of the mill owner's family. It is decorated with seasonal flowers and plants that give it a lived-in appearance.

A jitney ride takes visitors to the newest restoration project, the Hagley Soda House. Constructed in 1888, the handsome structure was used to store and process Chilean nitrate of soda until the mills closed. Then it became a residence, a library archives storehouse and a center for community events. Numerous events take place in the Hagley Soda House, including the annual Craft Fair in November and the Delaware Antique Show in December.

A number of historic buildings downstream from the main museum

building—Breck's Mill, Walker's Mill, and Walker's Bank—have been adapted to provide working and living space and usually are not open to the public. But there is much to see without them in this outstanding example of nineteenth-century industrial America.

LAWRENCE HALL OF SCIENCE

CENTENNIAL DRIVE, UNIVERSITY OF CALIFORNIA,
BERKELEY, CA 94720. Tel: (415) 642-5132.
Hours: Daily 10 am–4:30 pm, Thurs. 10 am–9 pm.
Admission: Weekdays: $1 general; Weekends: $2.50 adults, $1.50 students and senior citizens, $1 students under 18; free to children under 7.
Publications: Free brochure.
Reproductions: Postcard of the hall.
Research: Educational research facility for the staff.

The Lawrence Hall of Science in Berkeley differs from other American science and technology centers in two basic respects—it is operated by a university and is deeply involved in science curriculum development as well as exhibits and programs for the public and schools.

Lawrence Hall of Science was established by the regents of the University of California in 1958 as a memorial to Ernest Orlando Lawrence, developer of the cyclotron and the university's first Nobel laureate. The facility, perched on a hill overlooking the campus and bay, was opened in 1968 as part of the university's centennial celebration.

The science center is an integral part of the Berkeley campus of the University of California, although most of its financial support comes from other sources—primarily grants for research and development programs in the curriculum area.

The hall's activities fall into three broad categories—public services, research programs, and school resources. As a public science center, it serves some 250,000 visitors each year with exhibits, lectures, classes, films, and special events designed to stimulate curiosity and provide information on scientific topics. In its role as a research unit of the university, the hall develops science materials for schools and community groups. And as an educational resource for schools, it provides workshops for students and training for educators in the use of new materials and teaching techniques.

Lawrence Hall of Science is known for its development and evaluation of participatory science exhibits. In addition to producing its own exhibits, the Hall has developed exhibits for other science centers, shopping malls, hospitals, and community centers on a contract basis.

Lawrence Hall has the most extensive array of computer units of any science center—numbering more than 120. These computer terminals can be used for games, simulations, teaching, research, and even to produce music and natural language conversations. Some of the units are on the exhibit floors, while others are on hand in open, unstructured laboratories.

Other exhibits are concerned with physics, chemistry, mathematics, astronomy, biology, geology, energy, optics, and health. A memorial exhibit dedicated to Ernest Orlando Lawrence deals with nuclear physics.

At one of the hall's participatory exhibits, a child and her mother find computers both accessible and engaging. This one is programmed to interest children.

But the Hall offers much more than exhibits in its publicly oriented programs. There is a biology lab where visitors can handle gentle animals, a summer science-camp program, a laboratory where the public can perform physics experiments, sky shows in Holt Planetarium, science films for young children, star gazing with telescopes, and a full range of after-school and evening classes for all ages.

In the research area, the Lawrence Hall of Science has been involved in the development of science curricula and materials for schools since the 1950s. In recognition of this pioneering role, the National Science Foundation made its first grant to a research center in science education to the Hall.

The Science Curriculum Improvement Study, a seven-year elementary science program developed at the Hall, now is used by 20 percent of the elementary school students in the country. The Chemical Education Materials Study has been translated into sixteen languages and adopted throughout the world.

The third major area of the Hall activities—providing school resources—takes many forms. The hall seeks to supplement and enrich a school's curriculum through a diverse offering of science workshops and classes, featuring hands-on experiments and problem-solving activities. In addition,

the "Science Shuttle" brings programs to students in schools and science teachers can obtain assistance through special training workshops.

Single session science workshops in astronomy, biology, computer science, mathematics, and physics are offered to school groups that come to the Lawrence Hall on field trips. Students can observe stars in the planetarium, challenge a microcomputer in games of skill, investigate animal behavior, or engage in other such educational activities in these 50-minute sessions.

Multiple-visit courses—ranging from 60- to 90-minute sessions for four to twelve weeks—also are available. Similar on-site programs are offered to schools and community groups within 50 miles of Lawrence Hall. Children are challenged in the classroom to observe, experiment, and draw conclusions based on the data they collect.

Evidently, the Lawrence Hall of Science has a somewhat different bent from most science centers, largely because of its relationship with the Univerisity of California. Its research and school services give the Lawrence Hall a unique role in science education.

MARYLAND SCIENCE CENTER

601 LIGHT STREET, BALTIMORE, MD 21230. Tel: (301) 685-2370.

Hours: Winter: Mon–Thurs 10 am–5 pm, Fri–Sat 10 am–10 pm, Sun 12 noon–8 pm. Summer: 10 am–8 pm daily.

Admission: $3 adults, $2 students, senior citizens, $1.50 children under 12; $8 family rate.

Publications: *Vanguard*, a monthly newsletter.

Reproductions: Large selection of postcards, posters, prints, and slides of the museum exhibits and related subjects.

Research: Reference library open to visiting scientists by appointment. It is strong in geology and energy.

The Maryland Academy of Sciences, which was founded in 1797, opened the Maryland Science Center on Baltimore's revitalized Inner Harbor in 1976. This lively center makes it possible for visitors to journey from the depths of the sea to the outer reaches of space through three floors of interactive exhibits. You can see the variety of life forms in the Chesapeake Bay and exotic fish from faraway places; go back in time to the Earth's beginnings and cover 450 million years in just eight minutes; take a walk in the "Distorted Room;" play metric games and energy tick-tac-toe; program a video bug to draw; or have a consultation with "Dr. Know," the talking computer psychoanalyst. In addition, the museum has planetarium shows, live demonstrations, film programs, a discovery room, science classes and workshops and a popular travel-film lecture series.

MID-AMERICA MUSEUM

400 MID-AMERICA BOULEVARD,
HOT SPRINGS NATIONAL PARK, AR 71913. Tel: (501) 767-3461.

Hours: Tues–Sun 10 am–5 pm, closed Mon, New Year's, Thanksgiving, Christmas Eve and Day.

This hall focuses on ballooning. At center, top, a balloon floats unattached, inflated by an invisible stream of hot air, emitted center bottom.

Admission: $3.50 adults, $2.50 children 6–17 and senior citizens; free to children under 6.
Publications: Free brochures.
Reproductions: Some postcards of the exhibits and related subjects.
Research: None.

Located in the Ouachita Mountains near Hot Springs National Park, the Mid-America Museum was opened in 1978 by the State of Arkansas as an educational tool and tourist attraction. A participatory science center, it is concerned with human reactions, connections and experiences with the environment, and technological changes. Arkansas exhibits explore the relationships of a number of the state's traditional symbols—the razorback, traveler, toothpick, and bear. Other exhibits deal with perception, energy, matter, life, and natural resources management. The museum also has an aquarium, a current events gallery, a theater, and a collection of the farcical inventions created by Rowland Emett for the movie *Chitty Chitty Bang-Bang*.

MUSEUM OF SCIENCE

SCIENCE PARK, MCGRATH AND O'BRIEN HIGHWAYS,
BOSTON, MA 02114. Tel: (617) 723-2500.

Hours: Labor Day through Apr 30: Tues–Thurs 9 am–4 pm, Fri 9 am–10 pm, Sat 9 am–5 pm, Sun 10 am–5 pm. Open holidays, incl. Mon holidays 9 am–5 pm. Closed Thanksgiving, Christmas, and New Year's. May and June: Mon–Thurs 9 am–4 pm, other days as above. July and Aug: Mon–Thurs 9 am–5 pm, other days as above.
Admission: $5 adults, $3 children, students and senior citizens, free to members, children under 5 and Massachusetts teachers. $.50 extra for planetarium.
Publications: Newsletter and brochures for special exhibitions.
Reproductions: Postcards and slides of the museum and related subjects.
Research: Reference library open to public; strong children's section.

Boston's multifaceted Museum of Science is a contemporary creation of the Boston Society of Natural History, founded in 1830. The science center adopted its current name in the 1940s as it embraced the physical and life sciences and engineering, as well as the field of natural history.

At the close of World War II, the Museum of Science embarked upon an expanded role. The trustees voted to leave an old and inadequate building in the Back Bay for a new seven-acre site leased from the Metropolitan District Commission overlooking the Charles River Basin.

Starting with a temporary structure in 1949, the Museum launched a major building program at what it called "Science Park." The first permanent unit of the new museum—the East Wing—was opened in 1951. Then the Morse Auditorium was built in 1954 and the Charles Hayden Planetarium was completed in 1958. In 1972, the West Wing and an adjacent parking facility for 840 cars and 40 buses were completed. On the museum's 150th anniversary in 1980, the Elihu Thomson Theatre of Electrical Science was opened at the west end of Science Park.

Today, the sprawling museum covers 621,000 square feet, of which 121,500 feet are devoted to exhibits. It has become the largest science museum in New England under the leadership of Bradford Washburn, who served as director for 41 years before retiring in 1980.

Boston's Museum of Science is one of the few science museums that has extensive exhibits and educational programs in both natural history and technology. But its exciting new scientific and technological exhibits far outshine the more traditional animal and bird dioramas, fossil and insect collections, and other natural history exhibits (except for the impressive Tyrannosaurus rex, a large replica of a bipedal carnivorous dinosaur).

The museum also emphasizes New England in many of its exhibits—featuring environmental dioramas and scenes from early New England industries, such as lobster fishing and Paul Revere's workshop.

Among the museum's popular exhibits are a 90-foot-long wave tank, participatory computer units, a pyramid-building miniature diorama, a chick hatchery, an operating steam engine, astronomical exhibits, and full-sized models of space exploration vehicles.

The "Energy: Crisis and Challenge" exhibit includes a 15-foot-high roller coaster with 250 feet of convoluted track along which hurtles a gravity-

The world's largest air-insulated Van de Graaff generator creates lightning as part of a demonstration on electricity.

powered bowling ball in a demonstration of energy transfer and kinetic and potential energy; a colorful explanation of the sources and uses of energy; a full-sized, cross-sectioned house illustrating various types of insulation; and a computer station where visitors can obtain an analysis of how to save energy and money in their homes.

The Pierce Hall of Medicine and Health contains multi-unit exhibits on birth, blood, heart, body chemistry, cells, and the human body. A new medical exhibit in the Thomson Theatre of Electrical Science, titled "The Human Brain," explores the brain's structure and function with emphasis on its electrical nature. It features video, photos, and models, as well as specimens of human and animal brains, rarely seen by the general public.

The "Mathematica" exhibit—designed by Charles and Ray Eames and sponsored by IBM—has a history wall and hands-on units dealing with multiplication, probability, and other areas of mathematics. The exhibit is a duplicate of the one at the California Museum of Science and Industry in Los Angeles.

Demonstrations of the world's largest Van de Graaff generator are given regularly in the Elihu Thomson Theatre of Electrical Science. Built by MIT in 1932, the air-insulated generator has a historic place in twentieth-century nuclear physics. It originally was used for pioneering research on nuclear structure and experiments in atom-smashing. Later, it was utilized in studies of the properties of high-energy electrons and x-rays and to measure nuclear energy levels until it was superseded by more compact machines using compressed gases and producing higher voltages.

Among the other demonstrations at the Museum of Science are the talking transparent woman that explains the structure and functions of the human body; demonstrations of electricity, physics, and chemistry; and shows involving live animals, such as a great horned owl, a porcupine, and a boa constrictor.

The Charles Hayden Planetarium is one of the major facilities of its type in the nation, with a 300-seat capacity. It presents eleven different programs a year, lasting forty minutes and focusing on such topics as seasonal astronomy, atmospheric wonders, and calendars.

The Boston Museum offers a wide-ranging educational program that includes courses for children and adults, teacher programs, special lectures, science fiction and other films, a 30,000-volume library, a discovery room for young children, and "Eye-opener" programs for preschoolers.

The Museum's "Collaborative Education Program" is offered to public, private, and parochial school classes (free to Massachusetts students). Twelve programs on various science topics—from how life began to mathematics—are available, as well as four special-request and five planetarium programs. All are geared to grade levels. In 1981, some 112,300 students from 270 of the 351 cities and towns in the state, and 55,600 visitors from other states participated.

Some of these programs are given in Cahners Theatre, a fully equipped facility that permits dramatic treatments of such topics as sound, light, and vision. The theater also is used for the Lowell and Washburn lecture series which feature distinguished speakers on many aspects of science and technology.

Boston's Museum of Science seeks to arouse the curiosity and to stimulate interest in the world around us. Rather than being a research museum, it attempts to interpret science to the average person—thus becoming an educational resource for all ages. From all indications, it does a truly remarkable job.

MUSEUM OF SCIENCE AND INDUSTRY

57TH STREET AND LAKE SHORE DRIVE, CHICAGO, IL 60637.
Tel: (312) 684-1414.

Hours: Labor Day–Memorial Day: Mon–Fri 9:30 am–4 pm, Sat, Sun and holidays 9:30 am–5:30 pm. Memorial Day through Labor Day: 9:30 am–5:30 pm daily.
Admission: Free.
Publications: Free brochure; books:

Herman Kogan, *A Continuing Marvel*, 1973, $4.95.

Pictorial Guide, illustrated guide to museum, 1982, $2.95.
Exhibit Guide, a guidebook on exhibits, 1982, $1.17.
Visitor Guide, descriptive information on exhibits and programs, 1982, $.47.
Colleen Moore's Fairy Castle, 1981, $2.50.
U-505, the story of the German submarine's capture and conversion to an exhibit, 1981, $1.50.
Progress, bi-monthly newsletter on human activities.
Reproductions: Posters, postcards, and slides of many of the exhibits.
Research: Library open to public.

Opened in 1933, the Museum of Science and Industry in Chicago is the nation's oldest and largest contemporary science and technology museum. The Museum was founded largely through the efforts of Julius Rosenwald, a Chicago businessman and philanthropist, who was inspired by a 1911 visit to the Deutsches Museum in Munich, Germany. He was so fascinated by this new type of hands-on, enjoyable technical museum that he vowed to start a similar institution in Chicago.

In the 1920s, he enlisted the assistance of the Commercial Club, composed of Chicago's leading business and industrial leaders, offering a million dollars for exhibits if a suitable site could be found for such an innovative museum. In 1926, the museum was incorporated and a $5-million bond issue was passed to convert a temporary world's fair structure—the abandoned Palace of Fine Arts from the 1893 World's Columbian Exposition—into a permanent museum building.

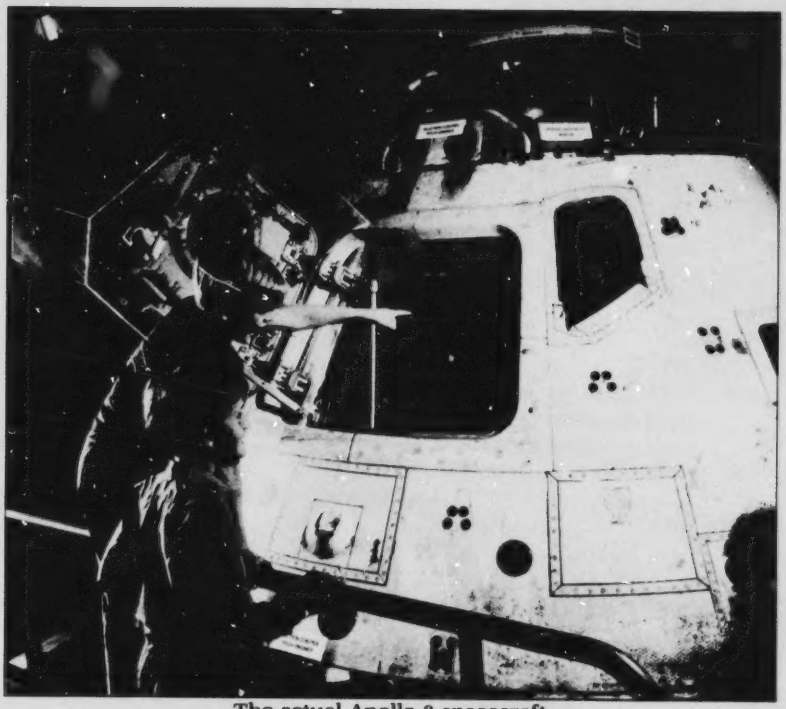
Although the Museum of Science and Industry opened in 1933, it was not until 1940 that the 600,000-square-foot building was completely renovated. Rosenwald increased his support of the museum to more than $7-million. Unfortunately, he died in 1932—a year before the opening of America's first successful science and technology center.

In the beginning, this Chicago museum was patterned closely after the Deutsches Museum. In addition to participatory exhibits, it had curators, historic collections, research programs, and other trappings of traditional museums.

But the direction was changed in 1940, when new president Lenox R. Lohr eliminated the curator system and sought outside advice for exhibit sponsorship, design, and construction. He made the exhibits more contemporary and interactive, less object-oriented, more dynamic. The result was an exciting and increasingly popular museum.

In recent years, the Museum of Science and Industry has placed greater emphasis on educational exhibits and programs—designed to further public understanding and appreciation of science, technology, industry, and health. Today, it attracts nearly four million visitors annually from every state and some 100 countries.

The museum has more than 2,000 exhibit units in seventy-five fields—including the basic sciences, energy, food and nutrition, communications, machine tools, computers, steelmaking, photography, medicine, automotive engineering, aerospace, hardwoods, rail transportation, agriculture, and water.



The actual Apollo 8 spacecraft, the first to orbit the Moon, can be explored by visitors.

Although best-known for its working coal mine and the U-505 Submarine exhibits, there is much more available to the visitor. One of the distinguishing characteristics of the science center is the scale and scope of its exhibits—with many of them ranging from 5,000 to 10,000 square feet in size.

The Coal Mine was the featured attraction when the museum opened a half-century ago. It is still extremely popular, largely because of periodic updating. The exhibit is a full-sized reproduction of a southern Illinois coal mine into which visitors descend via a real mine hoist. A guided tour explains how new machinery and technology have significantly advanced mining methods.

The U-505 Submarine is an actual German sub captured off the coast of Africa during World War II. It was the first enemy warship taken on the high seas by the U. S. Navy since the War of 1812. Visitors are taken through the submarine on guided tours and experience undersea life in the cramped quarters of this wartime relic.

One of the newest exhibits is the "Calculating to Computing" exhibit that

traces the history of computers, explains how they operate, points out some of their applications, and provides an opportunity to interact with eight terminals programmed with questions and games.

Many other exhibits make use of computers to transmit information. They include food and nutrition, banking and economics, agriculture, aviation, basic sciences, and the fiftieth anniversary exhibit on the impact of science and technology.

The "Food for Life" exhibit gives the visitor personalized nutritional information via the computer. Designed like an outdoor farmers' market, the exhibit also includes a chick hatchery and food sampling center.

Question-and-answer computers are utilized in the "Your Five Acres" and "Man in Flight" exhibits. Visitors experience growth patterns and extraterrestrial travel through computer simulation. By correctly manipulating the variables; a visitor guides one's ship to a landing on the moon.

Computers also are employed in the new "Science Universe" and "Technology: Chance or Choice?" exhibits. The computer units in the former deal with principles of science, while the latter poll visitors on their opinions about the impact and future direction of science and technology.

In addition to coal mining in the energy area, the museum has exhibits concerned with petroleum, natural gas, nuclear power, solar energy, automotive power, and water management. In the petroleum exhibit, visitors are taken on a ten-minute ride in pods on the world's longest articulated slat conveyer. On the roof of the museum are 7,000 square feet of solar panels used to heat and cool part of the building in a demonstration project.

The "Nobel Hall of Science" honors American scientists who have received the Nobel Prize in physics, chemistry, and medicine. It points out the value of basic research and describes how the prize-winning discoveries have advanced science and technology.

Among the other exhibits at the museum are: "The Farm," a full-scale barnyard; "Omnicom," relating scientific principles to communications; "Model Railroad," the world's largest miniature railway layout; "Newspapers in America," tracing the history, role, and operation of newspapers; "The Heart," with a 16-foot walk-through heart; "Yesterday's Main Street," depicting Chicago in 1910; "Artscience Gallery," featuring artworks based on science and technology; and "The Circus," with 22,000 hand-carved figurines and a spectacular 70-mm circus film.

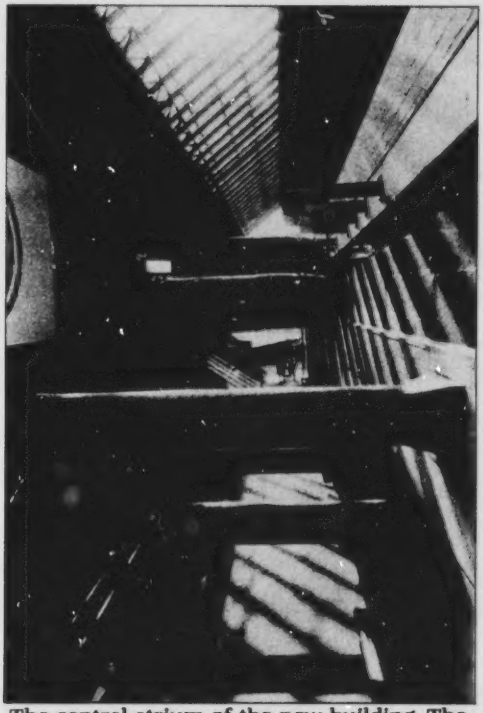
The museum also has an educational program that includes classes, science demonstrations, field trips, lectures, a summer camp program, a laboratory for independent research by youngsters and a new science library for children and teachers. It recently received a Mellon Foundation grant to develop new science education services that might serve as a prototype for science museums.

Against such a background, it is not surprising that the Museum of Science and Industry is the focal point of informal science education activity in Chicago and the city's leading tourist attraction. For the variety and quality of its exhibits, it is one of the nation's leading science museums.

MUSEUM OF SCIENCE AND INDUSTRY

4801 E. FOWLER AVENUE, TAMPA, FL 33617. Tel: (813) 985-5531.
Hours: Daily 10 am–4:30 pm, closed Thanksgiving, Christmas and New Year's.
Admission: $2 adults, $1 children 5–15.
Publications: Free brochure.
Reproductions: Postcards and posters of some exhibits.
Research: Reference library in process of being established.

Tampa's Museum of Science and Industry is a new project of the Hillsborough County Department of Museums. Located in an innovative, energy-efficient building, the museum replaced an outdated natural history facility. The first exhibits opened to the public in early 1982, with completion of the entire exhibit program scheduled for 1984. The exhibit concepts revolve around the importance of the sun to Florida, dealing with energy, weather, electricity, water environment, phosphates, agriculture, tourism, and related topics. Other activities include science classes, demonstrations, and traveling exhibits.



The central atrium of the new building. The ducts are part of the energy-efficient system around which the building was conceived.

NATIONAL MUSEUM OF AMERICAN HISTORY

CONSTITUTION AVE. BETWEEN 12TH AND 14TH STREETS, NW, WASHINGTON, DC 20560. Tel: (202) 357-1300.

Hours: Winter: daily 10 am–5:30 pm; Summer: daily 10 am–7:30 pm; closed Christmas Day.

Admission: Free.

Publications:

Shirley Abbott, *The National Museum of American History*. 1981, $60.

Reproductions: None.

Research: Library open to staff and outside researchers by appointment.

The Smithsonian Institution's National Museum of History and Technology in Washington became the National Museum of American History in 1980. The name change reflected a shift in the museum's direction—and an attempt to give it a new image.

"Technology" was removed from the museum's name, but the institution still remains one of the great storehouses of scientific and technological artifacts. The difference is that the objects now are viewed in terms of the nation's cultural and social history, rather than merely as technical relics.

Over the years, the National Museum has had difficulty in reconciling its history and technology roles. It was neither fish nor fowl. When Roger G. Kennedy, a Ford Foundation vice president, became director of the museum, he sought to clarify the dilemma and to give the "nation's attic" a new direction.

The National Museum of American History now describes itself as "a national center for the study and exposition of the history of American civilization." Through exhibits, research, and publications, it interprets American history and culture from folk art to developments in science and technology.

The museum is not—and never has been—a contemporary science and technology center. It always has been more concerned with collecting, restoring, conserving, and interpreting historic objects, rather than serving as a center of informal science education.

This is due to the museum's special place on the American museum scene. It is part of the Smithsonian's federal museum structure, and its primary purpose is to serve as a repository and interpreter for cultural, social, technical, political, military, and other artifacts of national value.

Although the Smithsonian Institution has been collecting such national treasures for more than a century, it was not until 1955 that Congress authorized construction of a building for the Museum of History and Technology. The structure opened to the public in 1964 and has been one of the most popular attractions in Washington ever since, attracting some four million visitors a year.

The museum has responsibility for the care and preservation of more than fifteen million objects. The scientific, technological, and industrial artifacts document the physical sciences and mathematics and emphasize American contributions to agriculture, mining, transportation, manufacturing, and medicine. Many of the objects came from the 1876 Centennial

Exposition in Philadelphia. Others were acquired when the Patent Office transferred some of its patent models to the museum in 1908 and in 1926.

The National Museum has more than 30 exhibit halls on three floors, including 45 period rooms displaying furnishings, tools, dress, and other aspects of the lives of our forefathers. Among the notable items on view are the Star-Spangled Banner, the desk used by Thomas Jefferson in drafting the Declaration of Independence, George Washington's wartime field headquarters, and a Model-T Ford.

Among the scientific, technological, and industrial exhibits are those dealing with the physical sciences, computing, photography, medical sciences, textiles, atom smashers, farm machinery, maritime, vehicles, electricity, tools, power machinery, railroads, bridges, ceramics, graphic arts, glass, typewriters, news media, timekeeping, musical instruments, ordinance, and underwater exploration.

The museum has a number of large thematic exhibits, such as "A Nation of Nations" and "We the People" (originally installed for the 1976 bicentennial celebration); "First Ladies' Gowns;" "Everyday Life in the American Past;" and "American Maritime Enterprise." The gowns of First Ladies set against an elegant tableau of period settings are among the most popular attractions of the museum.

The first thing a visitor usually sees upon entering the National Museum of American History off the Mall is the original 42- x 30-foot Star-Spangled Banner, hanging in tattered grandeur. It is the historic flag that flew over Fort McHenry during the successful defense against the British fleet in 1814. On seeing that "the flag was still there" the next morning, Francis Scott Key was inspired to write the words that later became the national anthem. The huge flag recently was cleaned and reinstalled.

Another impressive sight in the center of the building is the Foucault Pendulum, suspended 71-¼ feet from the fourth-floor ceiling. The pendulum demonstrates the rotation of the Earth as it swings over a marble pattern of a mariner's compass—knocking over the red markers around the perimeter.

The museum contains a wealth of historic objects—such as the first Duryea car from 1893, the 12-½-ton Pioneer locomotive from 1851, an 1888 automatic screw machine, Edison's first phonograph of 1877, astronomical instruments dating back to 1150, Samuel Slater's spinning frame of 1790, the Tuve-Van de Graaff particle accelerator of 1931, George Washington's false teeth, the Continental gunboat *Philadelphia* that was built and sunk in 1776, and the Dunning cyclotron of 1941 that was used to split the atom for the first time in the United States. Only a fraction of the museum's extensive collections is on display at any one time.

The National Museum of American History's educational activities are directed to both children and adults. There are regularly scheduled tours; special programs for the aged and handicapped; a series of concerts using antique instruments from the museum's collections; and discovery rooms, such as "Spirit of 1776" and "Electricity" where visitors may touch and handle objects during discussions conducted by volunteer guides. Educa-

tional materials take the form of publications, teacher's guides, audiovisual packages, and descriptive leaflets. In addition, the museum is active in television programming and film production related to its collections.

Although not normally evident to visitors, the museum has about 50 scholars and curators engaged in research in more than twenty specialties. The curators work and publish in areas ranging from American music to early locomotives and other steam engines. They are supported by a large research library, particularly rich in the history of science, technology, and economics. Another step in the development of the Museum as a center of scholarly study was the establishment of the Dwight D. Eisenhower Institute for Historical Research in 1975.

The National Museum of American History has been making changes in many of its exhibits, programs, and services, and quite a few galleries have been closed temporarily during the transition. But the barricades are not inhibiting because of the wide choice of outstanding offerings.

NEW YORK HALL OF SCIENCE

111TH STREET AND 48TH AVENUE, CORONA, NY 11368.
Tel: (212) 586-4004.
Hours: Tues–Fri 10 am–4 pm, Sat 10 am–5 pm, Sun 1–5 pm, closed Mon. Museum closed until 1984.
Admission: Suggested contribution.
Publications: Free fact sheet.
Reproductions: Postcards of the exhibits and an exhibit design workbook.
Research: Reference library.

The New York Hall of Science is located in the science building from the 1964–65 New York World's Fair in suburban Flushing. The museum currently is undergoing major building renovation and exhibit updating and expansion as part of an $11-million improvement program. The new museum will have 30,000 square feet of exhibits covering many areas of science and technology: a 300-seat multi-media theater; a 100-seat teaching planetrium; a satellite communication center; a media center and studio, and student laboratories and community meeting rooms.

OREGON MUSEUM OF SCIENCE AND INDUSTRY

4015 S.W. CANYON ROAD, PORTLAND, OR 97221.
Tel: (503) 222-2828.
Hours: Summer: Tues–Sat 9 am–8 pm, Sun, Mon 9 am–6 pm. Winter: daily 9 am–5 pm, Tues 9 am–8 pm.
Admission: $3 adults, $2 students 6–18 and senior citizens.
Publications: None.
Reproductions: Postcards of some exhibits.
Research: Library open to public. Education department and laboratories also available to the public.

In 1957, some 400 volunteer bricklayers and hod carriers came to a building site in Portland's west hills and laid 102,000 bricks in a single day to erect

the walls of a new museum. In this same spirit of community effort, other craftsmen donated their talents and suppliers their materials to complete the building.

It was through this unusual "barn-raising"—said to be the largest in the nation's history—that the Oregon Museum of Science and Industry obtained a new home and the impetus to become a center for informal science education in the Pacific Northwest.

OMSI—as the museum is known—had its beginning in 1944 as a natural history-oriented organization. Ten years later, the incorporation articles were amended and the name was changed to the Oregon Museum of Science and Industry to reflect the increasing emphasis on science and technology.

The decision to construct a new building was made when the old house the museum occupied was about to be torn down. After obtaining a $1 lease from the City of Portland for land near the zoo, the museum announced plans for a one-day barn-raising. The community response was overwhelming. The new building was dedicated in 1958—and a planetarium added in 1967.

The civic enthusiasm for OMSI has continued over the years as the museum has expanded and enhanced its exhibits, education programs, and community services, and increased its annual attendance to nearly 400,000. As the museum's literature states, "OMSI is dedicated to the proposition that science can be fun. Its exhibit halls are chock-full of displays that light up, go "beep," or play music, all demonstrating the supposedly staid principles of electrical generation, magnetism, computer science, energy conservation, mathematics, biology and the natural sciences."

The Portland science center is filled with participatory exhibits—such as the "Gravitram," a Rube Goldberg-like contraption that fascinates visitors of all ages; a walk-in heart; an authentic ship's bridge; a gyroscope; a DC-3 airplane; and "The Living End," where the public can pet an iguana or cuddle a baby chick.

The dramatic May 18, 1980 eruption of Mt. St. Helens is captured in a series of award-winning photographs. Visitors also may examine models of the mountain comparing its shape before and after the massive volcanic explosion. In addition, a seismograph shows how the movements of the earth are recorded.

Another exhibit explains what gives 3-D movies that extra dimension. Stereoscopic vision is explained as images float in space, moving pictures pop into real space at the turn of a knob, and a robot—called "3-D Man"—lets you see the world through his very special eyes.

A long-popular exhibit on human reproduction—entitled "Birth of a Baby"—recently was refurbished and updated. It is part of the health education exhibit section at OMSI.

The newest major exhibit is "The Computer Company," a multi-unit display funded by the National Science Foundation. It demonstrates the building blocks of a modern digital computer—from flip-flop circuits to a binary counter. "Dr. Know," a complete computer system, is programmed to give

psychological counseling. Designed and built at OMSI, the exhibit has been replicated for the Maryland Science Center in Baltimore and the Science Museum of Virginia in Richmond.

The museum's Kendall Planetarium can accommodate more than 400 people for its sky shows, multimedia presentations, and laser light musicals. OMSI also offers a variety of on-the-floor lectures and demonstrations on science-related topics.

The Oregon Museum of Science and Industry has developed a reputation for innovative educational programming. About 100,000 children and adults annually benefit from classes, group tours, traveling exhibits, field trips, independent research, summer camps, and other educational experiences.

Even before OMSI had its current building, educational offerings began with the establishment of a science camp in central Oregon in 1951. It was located in the fossil-rich John Day River valley. Today, Hancock Field Station serves as a major outdoor facility, helping about 1,000 campers each year with their studies in geology, ecology, astronomy, archaeology, botany and paleontology. OMSI also has added camp programs at a marine science station—Kiwanilong—along Oregon's Pacific coastline.

The year-round schedule of science enrichment classes ranges from beginning chemistry and astronomy for children to learning about lapidary and ornithology for adults. Field trips provide such experiences as a day-long family hunt in the Vernonia fossil beds and a teenage rock climbing excursion in the Cascades.

On Saturday mornings, the public is invited to use OMSI's computer equipment and software for research projects, self-education, personal business, or game playing. The museum was one of the first to create a "Research Center" to give children and adults an opportunity to carry out independent laboratory research.

OMSI also has an extensive outreach program that includes traveling "suitcase" exhibits, lectures, and science demonstrations. Its "Center for Energy Education" seeks to familiarize the public with issues and options regarding the use of all sources of energy.

Every September, OMSI's annual "Education Fly Out" takes a sampling of the museum's educational offerings to schools around the region. Pilots from the volunteer OMSI Aviation Committee and Portland's Columbia Aviation Country Club donate time and aircraft to fly OMSI representatives to communities throughout Oregon and surrounding states. More than 1,300 students have benefited from such programs in a single day.

Against this background of achievement, it is understandable why a Smithsonian Institution official called OMSI "the imaginative innovator of the museum world."

PACIFIC SCIENCE CENTER

200 SECOND AVENUE NORTH, SEATTLE, WA 98109.
Tel: (206) 625-9333.
Hours: Summer: daily 10 am–6 pm. Winter: weekdays 10 am–5 pm, weekends 10 am–6 pm.

Admission: $4 adults, $3 children and senior citizens.
Publications: Free brochure.
Reproductions: Postcards of some exhibits.
Research: None.

The six-building complex that houses the Pacific Science Center originally was the United States Science Pavilion for the 1962 Seattle World's Fair. After the fair, it was converted to a contemporary science and technology museum.

Today, the Pacific Science Center—with 109-foot "space gothic" arches and reflecting pools and fountains—serves some 600,000 visitors annually in one of the most beautiful museum settings to be found anywhere.

The center has over 50,000 square feet of exhibition space containing about 200 exhibits, most of which are participatory in nature. In addition, it features a planetarium, a computer center, a hemispherical theater, and a large-screen science theater.

Each year, special programs of science instruction are offered to approximately 60,000 students from 125 school districts in the Northwest. They are supplemented by courses using hands-on experiments and activities that serve an additional 5,000 students, as well as graduate teacher training programs in science education provided in cooperation with several regional colleges and universities.

Children play with the Bernoulli Ball. It floats on a column of air, demonstrating basic aerodynamic concepts.

The Pacific Science Center's exhibits range from volcanoes to space exploration to Indian artifacts. The "Volcano Watch" is a major exhibit on a nearby active volcano. It demonstrates real-time monitoring of the volcano's activity, explaining its complex geology. The space exhibit contains hardware and information dealing with space biomedicine and exploits, while the "Kwakiutl Coast Indian Loghouse" features archeological and art objects and serves as a stage for Northwest Indian theater, dance, and hands-on activities.

The popular traveling exhibition, "Creativity—the Human Resource," is now permanently located at the Pacific Science Center. The exhibit focuses on the creative process rather than product, and encourages visitors to test their own creativity through a variety of hands-on activities. American creativity is explored through videotapes, diaries, artifacts, and other materials pertaining to 15 contemporary artists and scientists, including Buckminster Fuller, Judy Chicago, Margaret Mead, and Jonas Salk.

Among other exhibits are the Puget Sound Exhibit and the Environmental Monitoring Center. The former exhibit gives a scaled-down view of the 1,020 square miles of water in Puget Sound, with a working model accelerating daily tidal cycles to illustrate water flow patterns and their effects. The environmental center focuses on why and how we monitor our surroundings. Exhibit activities include smell, touch, and visual tests, computer games, videotapes and an authentic submarine periscope used to assess air quality.

One of the science center's newest exhibits is the Science Playground, which features thirty hands-on physics experiments and activities. The basics of sound, light, color, momentum and mechanics are explained largely through participatory devices. Among the highlights are two five-foot parabolic whispering dishes for communicating across the room; an anti-gravity mirror which allows you to explore the symmetry of the human body in a fanciful way; a giant lever tht can be used to lift a 550-pound weight; a 72-foot-long echo tube for demonstrating how sound travels; ten glass pipes of graduated length that teach the concept of resonance; and a color wall showing how primary colors blend to make the other hues in the rainbow.

The Pacific Science Center is also known for its educational programming and special activities. There are interactive programs and exhibitions with local scientific clubs and organizations; special science programs for the gifted, handicapped, women, and minorities; work-study programs, science interpreter programs, and internships for high school and college students; more than 70 computers for learning and fun; teacher workshop programs; informal science classes for preschoolers, students, and adults; planetarium, large-screen theater, and laser shows and special events such as the "Science Circus," "Inventor's Fair," and "Science Fiction Film Festival."

Starlab Planetarium is quite small, seating only thirty-eight people. But it offers a full range of sky shows and astronomy education programs. In one of the nation's largest hemispherical theaters, daily laser light concerts are presented. The light images are choreographed to varied musical formats

from jazz and rock to classical. In 1979, the Eames Theater was renovated to create an IMAX theater with a 3-½-story screen. The 70-mm films produce the clearest image available in film, coupled with a sense of audience involvement.

More than 90,000 children and adults annually participate in a variety of school programs offered at the Pacific Science Center and in schools in the region. The "School for Science" program offers about 230 classes for preschoolers through adults in subjects ranging from astronomy to computers. The Science Center also provides four in-school programs—"Computer Van," "Stars and Snakes," "Science on Wheels," and "Starlab II Planetarium."

In the summer, the Pacific Science Center offers a Computer Camp and a Summer Science Camp. The Computer Day Camp allows 10- to 13-year-olds to learn programming, problem-solving, and computer operations. The Science Camp, held on Orcas Island, serves as an outdoor laboratory for youngsters to study marine biology, ecology, astronomy, and geology.

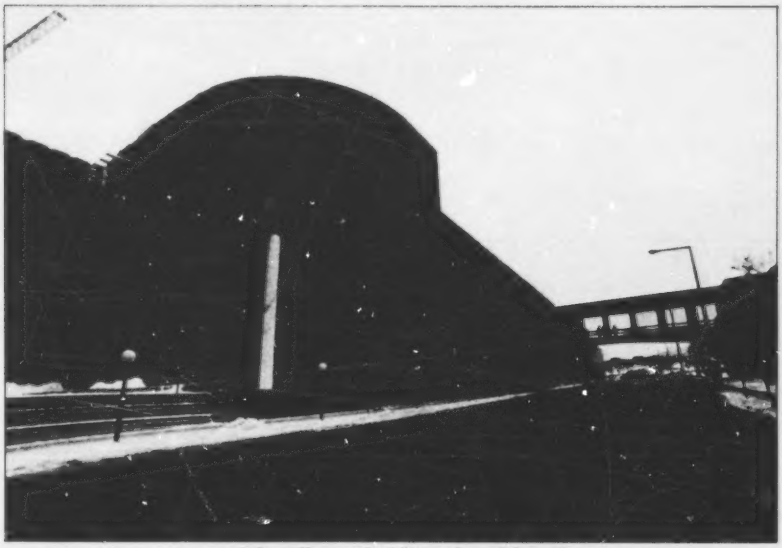
To help teachers, the center provides consultation, curricula materials and workshops. Among the special materials available are a computer courseware packet on nutrition for 6th to 8th grade students; a marine education curriculum complete with guides and kits; a teacher's guide for visually impaired students; and an energy time machine that simulates ways to coordinate energy supply and consumption with impacts on the global environment and food supply.

One of the most popular programs at the Pacific Science Center is "Science Circus," offered each year for ten days following Christmas. More than 30,000 people come to see the exhibit, and films, play games, watch live demonstrations, and have a good time. In spring, a two-day "Inventor's Fair" attracts ingenious individuals and their creations from throughout the Pacific Northwest.

SCIENCE MUSEUM OF MINNESOTA

30 E. 10TH STREET, ST. PAUL, MN 55101. Tel: (612) 221-9488.
Hours: Winter: Tues–Sat 9:30 am–9 pm, Sun 11 am–9 pm, closed Mon. Summer: Mon–Sat 9:30 am–9 pm, Sun 11 am–9 pm.
Admission: $3 adults, $2 children under 13 and senior citizens.
Publications: Free brochure.
Reproductions: Some postcards, and posters of Omnitheater.
Research: Reference library open to staff, members, and guests of curators.

The Science Museum of Minnesota in St. Paul was primarily a natural history museum until the late 1970s when a major expansion enabled it to add more exhibits in the physical sciences, as well as the "Omnitheater." In the Omnimax show, the audience is surrounded by a floor-to-ceiling screen covering 7,300 square feet and fish-eye lens is used to project 70 mm film onto the tilted dome. The new Hall of Technology exhibits deal with sensing, communicating, physical power, and problem solving. The hall also is the site of laser, robot, computer, oscilloscope, and electricity demonstrations.



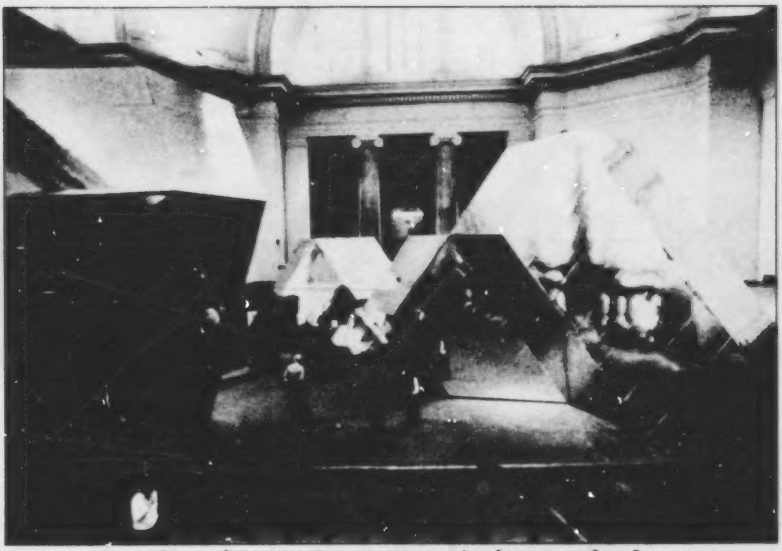
An aerial walkway bridges the old and new sections of the museum. The new building houses the physical science exhibits.

The science museum operates two nature centers near Marine-on-St. Croix and Afton and has an extensive educational program.

SCIENCE MUSEUM OF VIRGINIA

2500 W. BROAD STREET, RICHMOND, VA 23220. Tel: (804) 257-1013.
Hours: Mon–Sat 10 am–5 pm, Sun 1–5 pm.
Admission: $1.50 adults, $1 children 6–17 and senior citizens, free to children under 6 or in a family group.
Publications: Free brochures.
Reproductions: Posters and postcards of the exhibits and related subjects.
Research: Small reading room.

The Science Museum of Virginia was created as a state agency in 1970, but it did not have a building to house its exhibits and programs until 1977 when it opened in the old Broad Street railroad station. Since then, the museum has been restoring and renovating the station and developing new hands-on exhibits and education programs. Among the additions have been a discovery room, major exhibits on crystals and computers, an aquarium, and exhibit units on color, visual perception, motion, animation, sound and other aspects of science and technology. The most popular new attraction is the "Universe" planetarium/space theater that opened in 1983. Other units to be added include a health sciences wing, two floors on natural history, and industry and technology exhibits.



Housed in massive structures in the rotunda of the museum, the "Crystal World" is an educational exhibit about the science of crystallography.

SCIENCE MUSEUMS OF CHARLOTTE

DISCOVERY PLACE

301 N TYRON STREET, CHARLOTTE, NC 28202.

NATURE MUSEUM

1658 STERLING ROAD, CHARLOTTE, NC 28209. Tel: (704) 372-6261.

Hours: Discovery Place: Mon–Sat 9 am–6 pm, Sun 1–6 pm. Nature Museum: Mon–Sat 9 am–5 pm, Sun 2–5 pm.

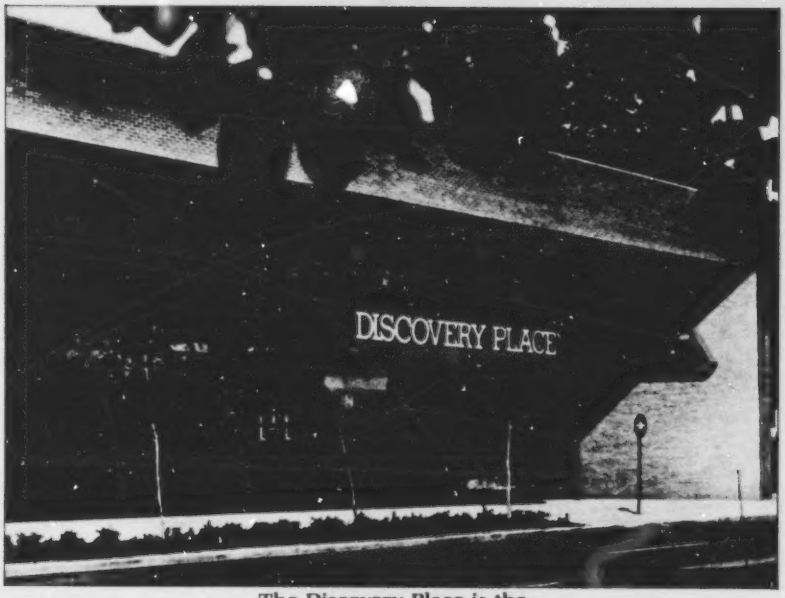
Admission: Discovery Place: $2.50 adults, $1.50 children 6–18 and senior citizens. Nature Museum: free.

Publications: Bi-monthly *Sciencefaction*, and free brochures.

Reproductions: Postcards of the Rain Forest.

Research: None.

Science Museums of Charlotte consists of two facilities—the long-established Nature Museum and the new Discovery Place. The Nature Museum has trails, a planetarium and nature-oriented exhibits for young children. Located downtown, Discovery Place deals primarily with science and technology. Among the exhibits are the Science Circus, featuring hands-on exhibits demonstrating science principles; Rain Forest, a recreated ecosystem of birds and plants; Life Center, exhibits explaining the human body; Energy Exhibits, pertaining to magnetism and electricity; Collections Gallery, cases and trays of specimens and artifacts; a replica of Michael



The Discovery Place is the new science center that is part of the overall museum.

Faraday's laboratory; and an aquarium. An extensive education program is offered, with the aid of four teachers assigned from the Charlotte/ Mecklenburg School System.

SCIENCE PLACE

FAIR PARK, PO BOX 11158, DALLAS, TX 75223. Tel: (214) 428-8351.
Hours: Tues–Sat 9 am–5 pm, Sun 1–5 pm, closed Monday.
Admission: $1 adults, $.50 students and senior citizens.
Publications: Free brochure for special exhibits.
Reproductions: None.
Research: Reference library open to public.

The Dallas Health and Science Museum changed its name to the Southwest Museum of Science and Technology in 1981, but operates as The Science Place. The one-time health museum is expanding into other fields and new facilities. In addition to enlarging its health and anatomy offerings, new exhibits are being developed in such areas as energy, communications, mathematics, transportation, environment, basic science, engineering, and space and astronomy. The Science Place also has a planetarium, the original "Gossamer Penguin" solar-powered aircraft, and popular education programs. By 1985, the science center will consist of its present facility and the nearby building vacated by the art museum in Fair Park.

CHAPTER FOUR

SPECIAL TOPICS

by
PAMELA ROGOW

BOSTON CHILDREN'S MUSEUM

MUSEUM WHARF, 300 CONGRESS STREET, BOSTON, MA 02210.
Tel: (617) 426-8855, events; (617) 426-6500, general.

Hours: Sat–Thurs 10 am–5 pm, Fri 10 am–9 pm, closed Mon except on school holidays, July through Labor Day, open daily.

Admission: $4 adults, $3 children 2–15 and senior citizens, free to children under 2; free Fri 6–9 pm.

Publications: Free brochures describe exhibits. Books relating to exhibits include:

Jerri Robinson, *Activities for Anyone, Anytime, Anywhere*. 1983, $5.95.
Bernard Zubrowski, *Ballpoint Pens*. 1979, $3.95.
——*Bubbles*. 1979, $3.95.
——*Drinking Straw Construction*. 1981, $4.95.

Reproductions: Kits derived from some study areas available for rental by teachers.

Research: Resource Center open to public. It is divided into study areas relating to the exhibits. Access to the museum collection in depth available through special exhibition study areas. Call in advance.

There was once a time when the typical museum had something of the ambience of a formal concert hall or a musty Victorian parlor. It was a place where children could be seen, perhaps, but certainly not heard. "Don't touch," parents would say. "Look with your eyes, not your hands."

But no more. In today's museums, kids learn by climbing, throwing, running, jumping and feeling—using not just their eyes, their minds and their hands, but the rest of their bodies as well. Representative of this new breed—and surely one of its best examples—is the Boston Children's Museum, located on the Boston waterfront.

The entry to the Museum, and an unmistakable landmark, is a three-story-high dairy stand shaped like a milk bottle where you can pick up a popsicle or buy an ice cream bar. From there you can go up a long, low ramp into an old four-story warehouse . . . and into another world.

A large part of the Children's Museum is devoted to what's called the "City Slice," which gives kids an X-ray view of the mysteries above and below a

city street. A three-story cutaway cross-section includes not just the street and the manholes (which kids can climb down in order to view the "underground" urban sub-structure of pipes and cables) but also a fully functioning "grandparents' house." This is complete with a parlor, a working kitchen, grandfather's cellar (where kids can pick up and have a whack at working with grandfather's tools), and grandmother's attic, where anyone who wants to can dress up in the hilariously obsolete clothes of their less chic-ly dressed elders.

To add to the liveliness and spontaneity of this part of the museum, high-school and college-age "interpreters" move through the scene, staging puppet shows, improvising games and generally keeping things interesting.

The fourth floor of the museum usually contains the more overtly "scientific" exhibits, but these are neither conventional nor formal. There is, of course, the by-now almost obligatory exhibit of computers, each programmed with games for kids and adults. These ask you to identify yourself by name when you start playing . . . and tell you by name when it's time for you to move on and give somebody else a turn. Another fourth-floor fixture is WKID, where youngsters have the chance to film and view a typical TV news show. WKID has a working TV camera, a screen (on which the director can see the results of his creative efforts) and a standard TV news set that includes a weather board, a desk, and a teleprompter. The child or adult who's acting as anchorperson reads the big stories about tody's weather or sports events right off the teleprompter while the other child runs the camera.

Also contributing to the scientific experiences of children is the Museum's "*bricoleur*-in-residence," Bernie Zubrowsky. *Bricoleur* means "tinkerer" in French, and Bernie Zubrowsky's job is to develop small-scale science activities from familiar objects . . . drinking straws, backyard materials, et al.

The fourth floor is also the place where visitors can see and, usually, participate in the imaginative and inventive exhibits devised by the Museum's "small science" developer Bernie Zubrowski. Among them is the wonderful "Bubbles" exhibit, where with string and a few other common items and the right brand of liquid dish detergent, kids can actually blow incredible eight-foot-long bubbles. Another Zubrowski special is the "Raceways" display. It consists of eight different tracks on which the racers aren't cars but (of all things) golf balls, which can ski-jump and loop-the-loop at impressive speeds—thereby demonstrating the principles of motion, momentum and velocity.

The key word is participation. The *What if You Couldn't . . . ?* exhibits and kits give non-disabled children the opportunity to experience visual, hearing, learning, emotional, mental and orthopedic handicaps. They can, for example, pilot wheelchairs over a variety of different surfaces or put on masks that obscure vision in increasing increments. There is also an impressive variety of kits and exhibits related to Boston's rich and influential ethnic sub-cultures—everything from Algonquin Indian to Irish, Italian, Jewish, West Indian, Puerto Rican, Chinese and Japanese.

Inspired by such experiences and exposures, the kids and their parents

can explore an entire section of the building housing a large store of books, slides, films, tapes, kits and objects to borrow, and a program of apprenticeships, workshops and courses to sustain all kinds of old and new-found interests.

As the Museum has changed to exemplify the switch from passive to active, from didactics to discovery, a philosophy of museum education has begun to emerge which one spokesperson, writing in *Museum News*, has summarized as the Boston Children's Museum doctrine of hook, line and sinker: "Within this doctrine, exhibits are the hook because their function is to catch a visitor's interest in a subject and hold onto it for a short period of time. Resources—books, audio-visual media, kits, workshops and courses by the Museum's subject specialists—are the sinker, because they can take an interested learner into a topic as far as he wants to go. The line between hook and sinker is the Museum's Resource Center, where adults and children can acquire learning materials and participate in extended education programs related to every major museum theme."

CAPITAL CHILDREN'S MUSEUM

800 3RD STREET, NE, WASHINGTON, DC 20002. Tel: (202) 543-8600.
Hours: Tues–Sat 10 am–4 pm, Sun 1–5 pm, closed Mon and major holidays.
Admission: $2 adult, $1 senior citizens, free to children under 1.
Publications: Free brochure.
Reproductions: Some postcards, posters and prints of the collection.
Research: Computer classroom open to public by appointment. Programs for ages 4 and up.

Parents who suspect that their children know a lot more about computers than they themselves do have that queasy hunch confirmed at the Capital Children's Museum in Washington, D.C., where the kids get hands-on experience with computers that do everything from composing music to teaching the principles of economics.

Uniquely interesting is the new Communication wing, in which visitors learn about different methods of human communication, from prehistoric cave paintings through codes, drums, writing, photography, telecommunications, fiber optics and (of course) computers. Everything in the Museum is scaled to kids' size and is carefully designed to hook their sometimes special interests. For example, the youngsters can send messages in Morse code, signal each other with Greek torches, connect calls to crank-up phones on an old-fashioned switchboard, or learn about the secret code of the hoboes. They can even send infrared-frequency messages from miniature Earth stations to a communications satellite.

CLEVELAND HEALTH EDUCATION MUSEUM

8911 EUCLID AVENUE, CLEVELAND, OH 44106. Tel: (216) 231-5010.
Hours: Mon–Sat 9 am–4:30 pm, Sun 1–4:30 pm, closed major holidays.
Admission: $2 adults, $1 senior citizens and children 6–17, free to children under 6. Tuesday ½ price family day.
Publications: Free fact sheet.

Reproductions: Posters and postcards of exhibitions in the museum.
Research: None.

Judge it by its name alone, and you might very likely decide that the Cleveland Health Education Museum is stuffy and pedantic, a place intended for medical students and other such scholarly types rather than for ordinary people interested in a fascinating and memorable show.

But if so, you'd be wrong. The museum's exhibits are dynamic, physical, and participatory. They are designed to make you aware of your *senses* and the way they work. Explore the "wonderful world of you," says the museum's literature, and that's precisely what its 157 exhibits and displays—all of them original, many of them unique—stimulate you to do.

It begins in a revolving theater. The stage whirls you into an electronic simulation of your brain, as orchestral music and some ten miles of flashing lights show you how the brain receives, records and reacts to message relayed to it through the senses. Then walk into the Theater of Sight, where you're at the center of the eye as it receives and responds to visual messages. Next, test your hearing; and for an unusual mixed-media experience, see how your voice looks in sound waves.

Now move on to Touch Island, where first you look at a big, comprehensively detailed human hand showing the nerve endings that sense hot and cold, pain and pressure, and transmit these sensations to the brain. Next, you're invited to touch objects that are hot and cold, hard and soft, scratchy and smooth . . . all intended to help you recall the hundreds of different tactile sensations you encounter in everyday life. At the next station you reach into dark boxes to identify small unknown objects, relying completely on your sense of touch. This part of the exhibit gives you confidence in your ability to identify familiar but unseen objects entirely by touch.

But the final station of Touch Island really tests that confidence. Here you reach into a dark box in an attempt to identify a big, complex, invisible object that has many different "feels" and must be touched from many different angles. Your brain has to put these "touch pictures" together like pieces of a jigsaw puzzle. But don't expect it to be easy. Like many of the Museum's visitors, you may leave the Island, go to the reception desk and ask, "What was in the last box?"

The Cleveland Health Education Museum was founded in 1936 by a group of local physicians, dentists and laymen, and its earliest exhibits were conventional look-and-don't-touch displays. But in 1950 came a brand-new arrival from Germany: the first fully automated multi-media exhibit in the Museum, and one of the first in the country. This was Juno, the transparent talking woman—designed to show and tell how body systems work. After more than thirty years, she's still talking.

The exhibits developed since Juno's debut have emphasized and expanded the see-touch-and-feel approach. Want to know more about dental health? Walk into the 18-foot Giant Tooth, through the enamel, past the dentin, and see just how complex that simple-looking structure in your mouth really is. While there, you and your kids can test your dental knowledge with

computer games, such as a dental crossword puzzle and dental "hangman"—competing against one another or against the computer.

What's important about nutrition? How long might you expect to live? Try some of the museum's newest exhibits: computers that ask you questions, give you answers and test your knowledge of your body. Stroll through Microbe Alley, where much-enlarged models of molds, fungi and bacteria surround you as you learn how they can hurt you and help you. See the Defense of Life exhibit, where you find out how your blood cells and enzymes move into action to protect you from infection. Then watch the drama in the Surgical Theater, an authentic operating room that reveals how a team of medical experts performs a hip transplant—one of the pioneer events in biomedical engineering.

Need a little help in telling the offspring what they ought to know about the birds and the bees? Then by all means take them into the Wonder of New Life exhibit, where the world-famous models sculpted by Dr. Robert Dickinson show how babies are born. Share the discovery of how sex is determined and how a person matures in the Theater of Sexuality. Learn about nutrition, pregnancy care, parenting and sexually transmitted diseases in the Theater of Social Concerns.

For the youngest youngsters of all, there's the Children's Health Fair, where talking animals tell them about their senses and nutrition, conveying what an amazing creation the body is. Let the kids crawl in and shake hands with Ophelia the Octopus (a memorable tactile experience), test their sense of smell on Howie the Hound or measure their height against Ginnie the Giraffe. The Wise Old Owl can tell them about their sight, and Pinky the Elephant knows a lot about hearing. When the youngsters sit in the Giant Head they can learn about dental care; and the Cupboard Wall will remind them of dangers to avoid around the house.

Clearly, there's something for everyone at the Cleveland Health Education Museum—something to see, hear, smell, touch, feel and learn.

THE COMPUTER MUSEUM

1 IRON WAY, MARLBORO, MA 01752. Tel: (617) 467-4036.
Hours: Sun–Fri 1–6 pm, closed Sat.
Admission: Free.
Publications: Free brochure.
Reproductions: Some postcards of the museum.
Research: None at present; library in progress.

Q: What was the world's first video game?

A: A game called *Spacewar* (what else?), invented by an M.I.T. researcher in 1962.

Q: Where is *Spacewar* now?

A: In the Computer Museum, of course.

To those who regard museums as repositories for items of archaeological or artistic or natural significance, it will no doubt come as a surprise that there *is* a museum for computers. The Computer Museum, located in the lobby and mezzanine of the Digital Equipment Corporation building, 45 minutes

from downtown Boston, (but will be located on the Museum Wharf after may, 1984) is a serious archive for scholars but also takes a broad and often playful view of its subject. You can see and sometimes even operate *Spacewar*, for example. There's a computer made of Tinkertoys that plays tick-tack-toe, and a flea market of mathematical treasures: outdated computers, huge and therefore obsolete components, even creaking, old gear-driven Comptometers and Monroe calculators, donated by Museum members and other computer buffs.

Even the 300-square-foot decorative murals in the Museum were created by computers programmed with artificial intelligence techniques. The program, devised by artist Harold Cohen, is operated by a self-directed set of rules and decisions that supposedly mimic the human process of art-making: Cohen programmed instructions about when to close a certain image and thus indicate a solid object, when to respect the "territorial boundaries" of other images, and so on. The result is strikingly handsome and perhaps a bit unsettling.

However, the prime aim of the Computer Museum is neither to amuse nor to unsettle, but to preserve genuine milestones in this new branch of history. It began when the president of DEC and an associate discovered that the giant 3,000-square-foot Whirlwind computer they had helped build at M.I.T. in the early fifties was about to be shipped off to a junkyard. They saved it, stored it and eventually helped organize the Museum under the directorship of Gwen Bell. The Whirlwind's core memory is now part of the permanent display. "If it weren't for us," says Bell, "all this would be thrown away, gone forever. We'd all be the poorer for the loss."

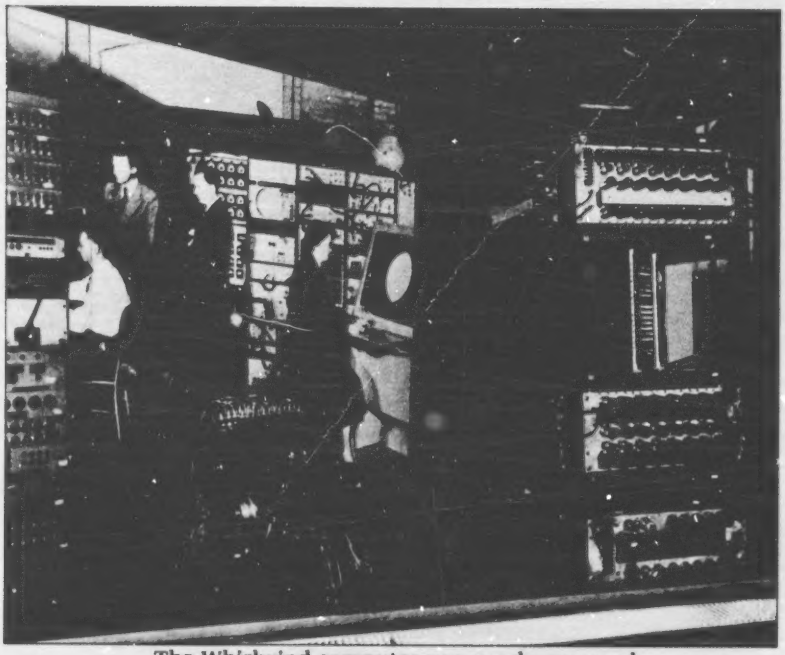
Other and earlier milestones are tucked into various corners of the museum. The earliest was devised by John Napier, who invented logarithms over 300 years ago. There is a set of "Napier's Bones," multiplication tables carved on pocket-sized cubes of boxwood. In another corner you'll see the fabled *Enigma*, a German-made World War II ciphering device that put military information into a nearly unbreakable code which the British were eventually able to crack.

But the main portion of the Museum highlights more recent history in the gallery of the "four computer generations," which illustrates the technological leaps that have resulted in today's sophisticated equipment:

The first generation started with the vacuum tube and the "flip-flop"—a circuit that could indicate either a one or a zero, the "binary" idea that led to the first true computers. But the members of this first generation were huge and unwieldy, and a youngster with a Snoopy calculator would probably be astonished to see how much metal, wiring and sheer complication it took to produce the answers to a few early questions.

The second generation of computers used transistors, which at the time—the late Forties—were considered the ultimate in compactness. As it turned out, they weren't.

The third generation used integrated circuits, in which the transistors, other elements and the wires to connect them were manufactured together rather than assembled one by one.



The Whirlwind computer was nearly scrapped before being saved by a few individuals who made it the center piece of the Computer Museum.

The fourth generation of computers—today's machines—uses tiny silicon chips in which thousands of microscopic circuit elements are packed close together. At the Museum the fourth-generation display includes the first low-cost home computer (an Altair) and an early Hewlett-Packard calculator that would have cost you nearly $400 in 1972, but only $10 today.

All this is interesting, not just to the casual drop-in visitor, but also to the people in the computer industry, who make the Museum a kind of home away from home.

About once a month a famous early pioneer explains how he made his discoveries in a lecture recorded for the Museum archives. On Sunday afternoons, people with provocative ideas about computers give informal talks, and the Museum provides refreshments. These sessions are called "Bits and Bites"—for bits of computer history and bites of good food. ("Bit" and "byte" also refer to a unit of information stored inside a computer: a computer-generated pun.)

The Computer Museum is the one place of its kind in the world. In its new, much expanded location, you'll set an absorbing look at the computer's short but jam-packed history and a thought-producing preview of its no-doubt formidable future.

CON EDISON CONSERVATION CENTER

405 LEXINGTON AVENUE, BETWEEN 42ND AND 43RD STREETS, NEW YORK, NY 10017. Tel: (212) 599-3435.
Hours: Mon–Sat 10 am–5:30 pm, closed Sun.
Admission: Free.
Publications: Free brochure.
Reproductions: None.
Research: None.

Most museums aim to stretch your intellect, your senses, your response to beauty. But not the Con Edison Conservation Center in New York City. It aims to stretch the contents of your wallet; and it ought to succeed.

Here, in one compact display, is everything you need to know about energy-saving ideas for homes and apartments: where and how it pays to weatherstrip and insulate; what energy-saving features and ratings to look for when you buy home appliances; the energy savings available when you switch from general lighting to "task" lighting; how to conserve and save money when you shower, shave, wash clothes, do the dishes. And in addition to the exhibits, there are live experts on hand to answer specific questions about your own home environment. This one isn't just a winner, it's a saver.

THE CORNING MUSEUM OF GLASS

CORNING GLASS CENTER, CORNING, NY 14831. Tel: (607) 937-5371.
Hours: Mon–Sun 9 am–5 pm, closed all major holidays.
Admission: $2.50 adults, $2 senior citizens, $1.25 children 6–17, free to children under 6; $6 family maximum.
Publications: Books, catalogues, pamphlets and brochures include:

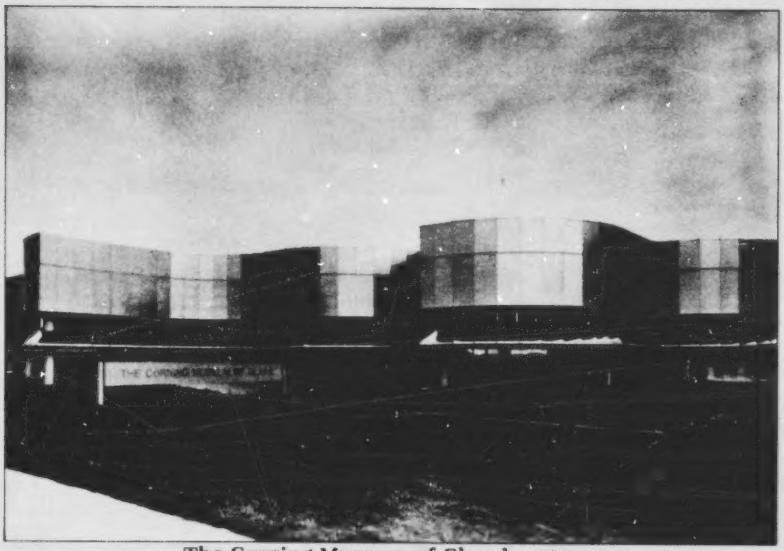
R.J. Charleston, *Masterpieces of Glass*. 1980, $40.
Mary Jean Madagan, *Steuben Glass: An American Tradition in Crystal*. nd, $55.
Harold Newman, *An Illustrated History of Glass*. nd, $27.50.
Jane Shadel Spillman, *American and European Pressed Glass in the Corning Museum*. nd, $25.
R. Stennett-Willson, *Modern Glass*. nd, $25.
Cloe Zerwick, *A Short History of Glass*. nd, $5.

Reproductions: Large selection of posters, prints, postcards, slides and microfiche of the collection and special exhibitions.
Research: Reference library open to public.

"The sun appears to dance across the fascia of a remarkable new building in Corning, New York, highlighting a billowing curve or throwing a recessed cover into deep shadow. At night the brilliant prism of the day becomes a lustrous pearl when the lights of the city ricochet off its many facets. Light seems irresistibly drawn to the Corning Museum of Glass . . ."

Architectural Record, February, 1981

At the Corning Museum of Glass, the medium—that is, the Museum itself—is an integral part of the message. And the message is that glass is one of the most exciting and versatile of all materials. In the words of Thomas S.



The Corning Museum of Glass boasts an artistic and atypical exterior comprised of glass panes covering almost 50,000 square feet.

Beuchner, president of the Museum: "People have been making glass for 35 centuries. Each piece . . . opaque or transparent, colored or clear, strong or fragile . . . is like a time capsule reflecting the ideas of its maker, of the techniques, practices and styles alive at the very moment at which it was made."

If this is indeed the case, the Museum, a spectacular "piece" if ever there was one, reflects the conviction that with our present technology one can achieve almost anything with glass materials. You can even use it to build a graceful, undulating, multi-faceted, nearly 50,000-square-foot glass house dedicated to displaying the glamour and glory of 3500 years of glassmaking.

The strikingly original Museum building itself is one of the prime attractions of the Corning display. Inside are more than 20,000 glass objects, the most comprehensive collection anywhere, each item representing a tantalizing mini-history of the tastes and temper of its time.

Glassmaking was probably invented in Mesopotamia (today's Iraq) where some of the solid glass beads and amulets on display here may have been made as long ago as 2500 B.C. More certain is the fact that after 1500 B.C., glass appeared in much-harder-to-make hollow forms—cups, bowls, and bottles—and was a clear sign of status. In Egypt, for example, only nobles, high priests, and pharaohs owned glass. Yet the glassmakers of the time used rolling, casting, or core-forming, techniques that would seem primitive after glassblowing was invented 1500 years later.

Blown glass first appeared in about 50 B.C. in the Syrian outposts of the

vast Roman Empire; artisans thereby could produce objects infinite in variety and exquisite in form.

But the Roman development of glassblowing also marked the beginning of the mass production of glass—and, ironically, the end of glass as a luxury product for aristocrats only. Glass mugs, jugs and beakers appeared in ordinary homes, public bars and restaurants, and even as souvenirs of the chariot races.

A typical drinking glass of the Frankish "barbarians" who eventually took over some of the fringes of the Roman Empire is on display. The glass is long and conical, and has no base. The reason being, if you were a lusty barbarian, you *never* set the glass down at all; you just drained it at a gulp and handed it back to your host for a refill.

By the eighth century A.D., Roman culture was dimming and Islamic culture was blooming. The Muslims were translating the Greek classics, pioneering in mathematics and medicine, and making sumptuous and intricately embellished glassware—cheerfully unintimidated, it appears, by the fact that their holy book, the Koran, frowns on luxury. Muslim glassware—mold-blown, relief-cut or enameled—is some of the most lavish made ever.

It was not until the Renaissance that fine glassmaking became reborn in Europe, and during that period the art reached new heights in Venice. Much of the Venetian glassware at Corning derives its esthetic identity from classic clarity and the sheer perfection of shape rather than from carving, cutting or other decoration. Venetian glass was so pure, it was believed by some that it would shatter instantly if it came in contact with poison.

Glassmaking was America's first industry, and soon American glass was as well-known and as much admired as the wares of the English and the Irish, the Germans and the Bohemians. But decorative and brilliant as these items were, they were *products* and primarily utilitarian—everything from bon-bon bowls and glittering chandeliers to low-cost and extraordinarily durable commericial containers.

The emergence of "art glass"—glass to look at, not to use—is only a hundred years old. It was born in France and nurtured by French designer-artists like Rousseau, Galle and Lalique; but this art form achieved its greatest fame through such American names as Tiffany and Steuben.

At the Corning Museum of Glass you can reflect on the long history of glassmaking to the extent of your time and inclination. Its galleries are arranged with four layers of display that increase in the number and density of the items shown as you move from the center.

If you have only twenty minutes or so, you can limit yourself to the "masterpiece" galleries, which house outstanding examples of each of the great ages of glassmaking. If you have forty minutes or an hour, treat yourself to the second layer, which holds display cases with about 150 additional objects from each of the great periods. The third layer takes an hour and a half or more, and the fourth layer, with many thousands of objects, is intended for serious students. Choose a layer and enter, or delve deeper in successive visits.

FERMI NATIONAL ACCELERATION LABORATORY

PO BOX 500, BATAVIA, IL 60510. Tel: (312) 840-3351.
Hours: Sun–Sat 8:30 am–5 pm.
Admission: Free.
Publications: Free brochure.
Reproductions: Some postcards of the laboratory.
Research: Library open to public 8:30–5 Mon–Fri. It is especially strong in high energy physics literature.

The Fermi National Acceleration Laboratory does research in a field that no layman can picture and few can conceive: high energy "particle" physics, which explores the basic properties of matter and energy by, for example, accelerating protons to 1000 billion electric volts. In order to accomplish such mystifying meta-miracles, Fermilab has set aside sections like its hyperon experimental area, its muon area, its pre-accelerator/booster-accelerator facilities and its machinery for examining quarks and anti-quarks. None of these is available to the interested public, which is probably just as well. What you *can* do at Fermilab is take a guided or self-guided tour through Wilson Hall, where you can see a scale model of the laboratory site, a spark chamber that helps you visualize the astonishingly tiny and powerful particle interactions studied by its scientists and a thirteen-minute slide show that gives a basic but revealing description of the work done here.

LAWRENCE LIVERMORE NATIONAL LABORATORY

PO BOX 808, LIVERMORE, CA 94550. Tel: (415) 422-9797.
Hours: Mon–Fri 9 am–5 pm, Sat, Sun 12–5 pm, closed holidays.
Admission: Free.
Publications: Scientific papers available to public through Government Reports Announcements of the DOE.
Reproductions: None.
Research: Research library closed for security reasons. Persons who obtain clearance may apply for an appointment.

The Lawrence Livermore National Laboratory is operated by the University of California for the U.S. Department of Energy. It is best known for its development of nuclear weapons for the nation's "strategic deterrent" missile forces, and is responsible for such weapons from conception to what's known as "retirement." Much of the weapons effort is based on classified research in such fields as physics and materials science, and the laboratory is also active in the analysis and solution of problems relating to energy and the environment. Activities like these are featured at its well-organized Visitors Center. Among the most interesting displays: a multi-media presentation highlighting each of the Laboratory's major scientific programs; sound and color videotapes showing Laboratory facilities not readily accessible—like the Nevada Test Site and its underground linear accelerator. Always on hand are trained bilingual docents.

THE MESA LABORATORY OF THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

PO BOX 3000, BOULDER, CO 80307. Tel: (303) 494-5151 ext. 262.
Hours: Mon–Fri 8 am–5 pm, Sat–Sun and holidays 9 am–3 pm.
Admission: Free.
Publications: Free brochure.
Reproductions: Postcards of the building and environs.
Research: Reference library open to public weekdays 8 am–5 pm. It is strong in atmospheric sciences.

The Mesa Laboratory of the National Center for Atmospheric Research is an extraordinary combination of scientific experimental research station/museum and nature preserve. The Mesa Lab, which is surrounded by a 400-acre site at the southwest edge of Boulder, Colorado, performs sophisticated investigations of winds, clouds, humidity and global weather systems, has weather-oriented displays for visitors and offers brochures that tell you how to make an intelligent self-guided tour of the building.

The Lab is also the starting point for the Mesa Nature Trail, a 6000-foot-high natural sanctuary that covers the subtle but dramatic transition from grassland to foothills and from foothills to the montane zone in less than a half-mile. The trail is well-marked and its unusually diverse plants and animals are clearly identified and described in a booklet also available at the Lab. To help protect this fragile environment, you're urged to take only photographs, leave only footprints.

MUSEUM OF BROADCASTING

1 EAST 53RD STREET, NEW YORK, NY 10022. Tel: (212) 752-7684.
Hours: Tues–Sat 12–5 pm, closed Sun–Mon.
Admission: Voluntary contribution $3 adults, $2 students, $1.50 senior citizens and children.
Publications: Brochures and catalogues at nominal prices.
Reproductions: Posters.
Research: File catalogue of scripts and programs available to the public.

The time was the early fifties, one of the most unlikely periods in the history of free-thinking America. For an historic and unprecedented show, the skillful and impeccably articulate CBS newsman, Edward R. Murrow, had put together a damning masterpiece of do-it-to-yourself incrimination: a collage of television and newsreel clips of Joseph McCarthy, in which the Senator from Wisconsin made the gross and undocumented accusations of "Communist treason in high places" that had anesthetized the mouths and minds of millions of Americans. Murrow's show was devastating—as was its follow-up the next week, when CBS gave the blustering, shrill and sometimes hysterical McCarthy equal time to reply. Seeing it now, one can hardly believe that so many Americans could have been so thoroughly cowed by such a demagogue.

And you *can* see it now at The Museum of Broadcasting, which maintains a growing collection of important radio and television programs that can be

looked at, and listened to, at one of the institution's custom-designed broadcast consoles. The collection acts as an informal history of our fads, fancies and follies.

Here, for example, are just a few of the events you can see and hear:

—The Beatles' first tour in America; in retrospect, their music seems so conservative, their hair looks so *short*. And the first TV appearance of Elvis Presley during which the camera's eye never strayed below his belt.

—Radio coverage of the triumphal 1927 return to the U.S. of Charles "Lucky Lindy" Lindbergh and the radio debut of those other popular heroes, Amos 'n' Andy.

—The classic Orson Welles radio presentation of H. G. Wells's "The War of the Worlds." Can all those people *really* have thought the Martians were coming? Well, when you hear how cleverly the "invasion" was announced—as an unscheduled "news" interruption to a Lawrence Welkish program of dance music—and then consider America's current willingness to believe in Amityville horrors and Bermuda triangles, the whole thing may not seem so surprising, after all.

—A full broadcast day at the beginning of World War II, September 1, 1939; and the war's end on V-J Day, August 14, 1945. Listen also to the collection of propaganda broadcasts made by Americans and Englishmen working for the Axis powers: Lord Haw Haw, Axis Sally, Tokyo Rose and Ezra Pound.

—A 90-minute collection of classic commercials.

—And how about the radio debut of twelve-year-old Judy Garland? The incomparable comedy routines of Jack Benny, Fred Allen, Beatrice Lillie, Groucho Marx? And for contrast, the report of Hitler's troops taking over the Louvre?

—There's a collection of important technological and historical "firsts"—among them, the first transcontinental television broadcast (coverage of President Truman's signing of the Japanese Peace Treaty in 1951); the first Presidential tour of the White House (Truman, 1951); and the Kefauver crime hearings of 1951.

—For people with an interest in electoral politics, there's the full record of the Kennedy-Nixon debates and speeches by each of the ten Presidents of the United States since Warren G. Harding. For those who prefer the more obvious forms of show business, there is rare musical, comedic and dramatic material from the 1920s, including the music of the Rhythm Boys (one of them was Bing Crosby) with Paul Whiteman's orchestra and numerous other surprises.

The Museum of Broadcasting is the first American institution dedicated to the study and preservation of radio and television technology. It has the full support and cooperation of all the commercial networks and of public broadcasting. Its holdings include some 20,000 programs, all carefully catalogued and indexed, and easily accessible to the visitor through an extensive but simple-to-handle computer-generated file of index cards. Once you find what you're looking for, you simply reserve the time to see or hear it at one of the broadcast consoles. The Museum also maintains a library of

rare radio and television scripts along with books and periodicals on the technology of broadcasting.

All this is immensely appealing, not just to the public but also to serious students of broadcasting. The Museum is, in fact, reserved for school groups of all ages.

A visit to the Museum demonstrates that these varied uses—technological study, historical examination and sheer nostalgia—can operate together with perfect smoothness. At any given time you might see a student tracing the evolution of such technological breakthroughs as mini-cameras and edit-as-you-go mobile mixers and monitors, and their growing impact on the style and substance of TV programming.

In another corner you'll see a mother reliving the thrill of her own youth as she shows her children how marvelous Mary Martin looked when she flew through the air as Peter Pan. And at another console a sociologist is studying the portrayal of women in the commercials of the 1950s, trying to gauge their effect on the self-imaging and self-esteem of the real women of that period.

MUSEUM OF HOLOGRAPHY

11 MERCER STREET, NEW YORK, NY 10013. Tel: (212) 925-0526.

Hours: Wed 12–6 pm, Thurs 12–9 pm, Fri–Sun 12–6 pm, closed Mon–Tues.

Admission: $2.75 adults, $1.50 children and senior citizens.

Publications: Books, pamphlets and brochures include:

R. Collier, C. Burckhardt, L. Lin, *Optical Holography*. 1977, $27.50.

G. Dowbenko, *Homegrown Holography*. 1977, $8.95.

J. Hecht D. Teresi, *Laser: Supertool of the 1980's*. 1982, $14.95.

G. Saxby, *Holograms*. 1980, $24.95.

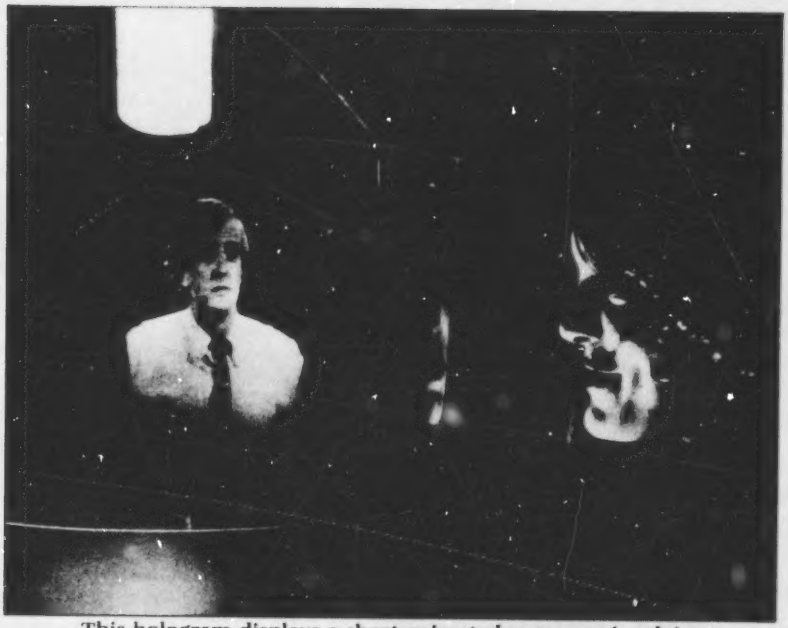
Reproductions: Holographic and flat movies; dichromate, reflection, printed and white-light holograms available.

Research: Lending archive of black and white prints and color slides. Reference library open to members and press free, to public for $10. Largest collection on holography in the world.

Imagine walking past a curved plastic screen and seeing a little lady inside the screen blow a kiss and wink at you as you go by. She's a miniature, lit in rainbow colors that change as you change position, and she moves like a living person. But when you reach out to touch her, your hand finds empty space in the very spot that she appears to be in.

This "holographic movie" is one of a hundred beguiling 3-D images at the Museum of Holography in New York's SoHo area. Housed in a picturesque 19th-century cast-iron building, this young and modest institution is the world's leading center for information on holography. Its collection of 1,500 holograms is the best in the world.

Holography is a technically complex kind of photography that produces 3-D images. The finished product is a glass or plastic plate called a hologram; scenes appear to float behind it (or, for another kind of hologram, in front of it). The plate contains a microscopic pattern of wavy lines that is created with laser light. When you illuminate the hologram from the correct angle,



This hologram displays a short animated sequence involving William F. Buckley, Jr. It is found, along with other examples of New York notables, in the museum's Contemporary Portrait Gallery

the light that goes through it (or reflects from it) is bent into an eye-fooling image. A hologram is similar to a phonograph record—it contains a pattern that is "played back" to produce emanations of the real thing.

Holography was invented decades ago, but didn't catch on until lasers became practical. Today, holography has technical applications (in supermarket scanners that read UPC bar codes, and in test equipment for tires and other materials), but it is also an artistic medium. Many artists are fascinated by holography and continue to develop the technique.

The Museum of Holography contains everything you might want to know about the hologram as an art form. Museum staff members make holograms, and they are in close communication with the 250-or-so holographers worldwide. They maintain a comprehensive library and publish a journal. Their two traveling exhibitions have been displayed at museums across the country. Periodically, they mount a show featuring the best of the new works being produced by artist-holographers from SoHo to Amsterdam.

The contemporary art-holograms are on view on the main floor. Some of them combine the real and the imaginary—an actual candle on which you see an evanescent holographic flame. Other displays are holograms of holograms, making the scene appear to recede into infinity. While some of

the holograms are technically impressive but visually banal or confusing, the best of them twist light in remarkable ways.

They constitute a 3-D art very different from sculpture—it has to be seen to be understood. Visit "Light Years," a gallery featuring holograms from the museum's permanent collection.

Should you want to make your own 3-D images, museum staff will explain how to go about setting up a holographic studio. Before you decide to try your hand at holography, be aware that your subject matter is limited to small, motionless objects, like seashells, unless you have access to a large laser.

Visitors wanting to understand something of the history of holography can spend time in the gallery, "In Perspective." Unlike the artworks, this display is intended to be instructional rather than just entertaining and esthetically intriguing.

It moves step by step from the first holograms through the advancement of the technique, explaining who was responsible for innovations and what these led to. Part of the display includes exhibits that help illustrate the meaning of "3-D image." You'll learn, for example, that a vast amount of information is stored in a hologram; if it breaks, you can still see the entire image through each piece, but the scene is dimmer and your viewing angle is limited. If, on the other hand, you tear a photograph in pieces, each piece shows only part of the scene.

You needn't understand holograms to find them fascinating, as is attested by visitors to the museum's "Contemporary Portrait Gallery," the most popular display. The gallery contains commissioned holographic portraits of well-known New Yorkers, including Andy Warhol, William F. Buckley, Arthur Ashe, Big Bird, and others. Each portrait is a 3-D movie that shows its subject doing something characteristic. (Writer Pete Hamill types and smiles as the visitor walks by!)

Few visitors resist stopping at the Museum bookstore to pick up an eye-catching souvenir. The store sells not only books, but holograms and holographic paraphernalia of many shapes, sizes, and prices. They include the holographic movie of a little lady blowing a kiss; a dazzling science-fiction landscape; and jewelry and belt buckles emblazoned with a Möbius strip, a pyramid, or a realistic human eye. The gifts are as crisply three-dimensional as the rest of the Museum's offerings.

Most visitors to the Museum are there for the first time. They say things like "Is it real?" "Look, its moving!" and "How do they do it?" A film that runs continuously explains the basic procedure and answers some of the questions. But it's pretty heavy going. People with some knowledge of holography will learn a great deal from a visit to the Museum and from Museum programs to promote the art. People who just want to find out what holography is will get a gratifying eyeful of definitions—in color and 3-D.

Museum founder and director Posy Jackson has called holography "the most revolutionary visual recording medium since the prehistoric cave paintings at Lascaux." It is not clear when and how holography's potential

will be fully realized, but Jackson and her staff will be documenting each step along the way.

THE MUTTER MUSEUM OF THE COLLEGE OF PHYSICIANS OF PHILADELPHIA

19 SOUTH 22ND STREET, PHILADELPHIA, PA 19103.
Tel: (215) 561-6050, x41.
Hours: Tues–Fri 10 am–4 pm.
Admission: Free.
Publications: None.
Reproductions: None.
Research: Medical library open to public has materials dating back to Colonial times.

The Mutter Museum in Philadelphia is a fascinating and occasionally fearsome collection of medical memorabilia. It was founded in 1863—long before the discovery of antibiotics and sonography, X-ray, and blood transfusions—and only a few years after anesthetic gases started to replace a stiff jolt of brandy or a stoical biting of the bullet as the prime painkillers during surgery. Not surprisingly, most of the Mutter's exhibits will not remind you of the high-tech, antiseptic, digitally-monitored world of modern medicine. You'll see old medicine chests and instruments, ancient infant-feeding bottles, shrunken heads, thousands of neatly organized objects, many of them totally unlikely, that have been surgically removed from

The Hyrtl Skull Case includes background notes on each individual whose remains are found here.

humans, and a wall "decorated" with some 139 human skulls, each labeled with information about the identity and habits of its probably unwitting donor.

MYSTIC SEAPORT MUSEUM

MYSTIC, CT 06355. Tel: (203) 572-0711.

Hours: Sun–Sat 9 am–5 pm; some summer exhibits open until 7; closed Christmas.

Admission: $8 adults, $7 senior citizens, $4 children 5–15. Children under 5 free.

Publications: Numerous books, catalogues and brochures include:

Robert G. Albion, William A. Baker, Benjamin W. Larabee, *New England and the Sea*. 1972, $9.

Maynard Bray, *Watercraft*. 1979, $18.

John F. Leavitt, *The Charles W. Morgan*. 1973, $8.

Richard C. Malley, *Graven by the Fisherman Themselves*. 1983, $16.

Barry Thomas, *Building the Herreshoff Dinghy: The Manufacturer's Method*. 1979, $5.

Reproductions: Posters, prints, postcards and slides of the museum and its exhibits.

Research: Research library open to researchers by appointment. It has one of largest maritime book collections in the country.

There was a time when people who sometimes slept outdoors (which in some areas was just about everybody) knew, as a result of simple and casual observation, that the changing positions of moon, planets, and stars bore a telling relationship to their own location here on earth. This once-common understanding of the cosmic connection was the basis of navigation and exploration.

But today city-dwellers seldom even see the stars: there is too much competition from the Golden Arches, other neon institutions and pollution. Celestial navigation, though it's no less important today than in earlier centuries, has become an esoteric science, known only to working specialists and a scattering of astronomy fans—and to alert visitors to the Seaport Planetarium at Mystic Seaport, Connecticut. Here, daily shows demonstrate what one museum brochure calls the "secrets" of the stars and the earth-sky relationships.

Celestial navigation is just one of the many technologies and crafts demonstrated and displayed at Mystic Seaport, which consists of scores of handsomely restored exhibits—buildings, ships and boats—located in and along the waterfront of the Mystic River and dedicated to America's maritime heritage.

Many of the ships, shops and homes are alive with skills and crafts that were once the basis of a booming port economy. In the museum you can often see craftspeople at work with their special tools and materials, maintaining or refurbishing the collection of vessels for "show" as their predecessors once did for "go." There's a workshop where whaling implements are forged for use in the displays; a shop which made the special wooden hoops designed to hold sail to mast on fore-and-aft rigged ships. There's a cooperage and a cordage company as well as a chandler, all essential in producing the goods that outfitted ships and sailors for long

The Charles Mallory sail loft was active during a time which predated blueprints for sail production. The loft's size was necessary for every step of the sailmaking process.

voyages. There's an oldtime bank and shipping office, even a newspaper and job-printing shop that display the tools and technology of the journeyman printer's trade.

Some of the most interesting exhibits reveal day-to-day difficulties that later generations never imagined. There's the Charles Mallory sail loft, for instance, where the sails for Mystic's ships are measured, cut and sewn. In the old days, this wasn't easy. Before sail-area blueprints became commonplace, sailmakers were their own patternmakers. They'd measure the masts and yards of the ship; then, using a carefully scaled paper pattern, the outline of the sail was sketched on the floor of the loft. In order to keep this workspace open, free and fully usable, their pot-bellied heating stove had to be suspended from the ceiling.

Most of all, there are the boats, big and small. Mystic Seaport's collection of small craft is the largest in the country, and perhaps in the world. It includes more than 200 sailboats, rowboats and power-boats, ranging in

type from yachts and workboats to dories and canoes, all offering a view of the early propulsion systems: not just sail and steam, but also gasoline.

Most appealing, by far, to Mystic Seaport visitors, are the big ships. Walk the decks, for instance, of the world-famous wooden whaleship *Charles W. Morgan*, built in 1841 and now the last of her breed. One hundred and thirteen feet long with a 27½ foot beam, she can carry some 13,000 square feet of sail. The huge rendering pots once used for converting whale blubber into oil are forward. Below are incredibly cramped quarters in which the *Morgan's* officers and crew lived—sometimes for years at a time.

Then go aboard the square-rigged *Joseph Conrad*, a splendid 103-foot vessel built in Copenhagen in 1882 and one of the smallest full-rigged ships made in modern times. It was designed to accommodate eighty boys in training for the Danish merchant service—and is still used as a training ship for the Mystic mariner-education program.

Go below on the trim, fleet fishing schooner *L.A. Dunton*, made and launched in Massachusetts in 1921. Built after auxiliary gasoline engines had become commonplace, it was probably the last large fishing schooner that was powered by sail alone; the few such ships built later were made for racing, not for commerce. The *Dunton* was eventually equipped with an engine, too—but just temporarily. When she was acquired by the Museum, her diesel engine was removed and her original stern, deck, and topside painstakingly restored—all necessary, the Museum says, "to maintain the *Dunton* as an example of the finest type of American fishing schooner, and a testimonial to the hard-working fishermen who manned her."

Though many of Mystic Seaport's big ships spend most of their time in the water, only one can actually take you cruising on the Mystic River. This is the *Sabino*, built in 1908 and now the last remaining coal-fired, steam-powered passenger ferry in operation in the U.S. During the winter the *Sabino* is usually on view in the shipyard. In the warmer months, generally from May through October—she makes regularly scheduled runs for the education and enjoyment of Mystic Seaport visitors.

NATIONAL MUSEUM OF TRANSPORT

3015 BARRETT STATION ROAD, SAINT LOUIS, MO 63122.
Tel: (314) 965-7998.
Hours: Sun–Sat 9 am–5 pm, closed Thanksgiving, Christmas, New Year's.
Admission: $2 adults, $1 children 5–12 and senior citizens.
Publications:
Clifford Saxton Jr., *National Museum of Transport: Catalogue of the Collections*. 1980, $1.50.
Reproductions: Posters, prints and postcards of objects in the collection.
Research: None.

If your idea of the greatest way to get from place to place is by aircraft, space shuttle or skateboard, you may not find the National Museum of Transport in St. Louis irresistibly attractive. True: it has a small but respectable collection of old cars and horse-drawn buggies; an unusual assortment of early and late fire and mail trucks: a steamroller, a street

sweeper, a double-decker bus from London, and even a jinricksha, but . . .

But if trains are what turn you on—this is the place.

This is where you will find hundreds of significant exhibits that trace and illustrate the technological developments during the great heyday of trains in America. Here are endless examples of the classic old steam locomotives, of late and early diesels, of special-function coast-to-coast or inter-city trains that tried (but usually failed) to cope with the increasing dominance of planes, trucks and buses. You'll also see private cars, "office cars," dining cars, observation cars and Pullmans that will give anyone accustomed to the claustrophobic styrofoam surroundings of a jetliner, a whole new definition of "elegant travel."

In 1911, Pullman created an office car for the Delaware and Hudson Line. The interior is impressively paneled in walnut, and contains two staterooms (with bath), a lounge, special quarters for the crew, and a luxurious dining room. The latter section includes handsome leaded-glass cabinets in which are displayed the monogrammed D&H silverware and Spode china.

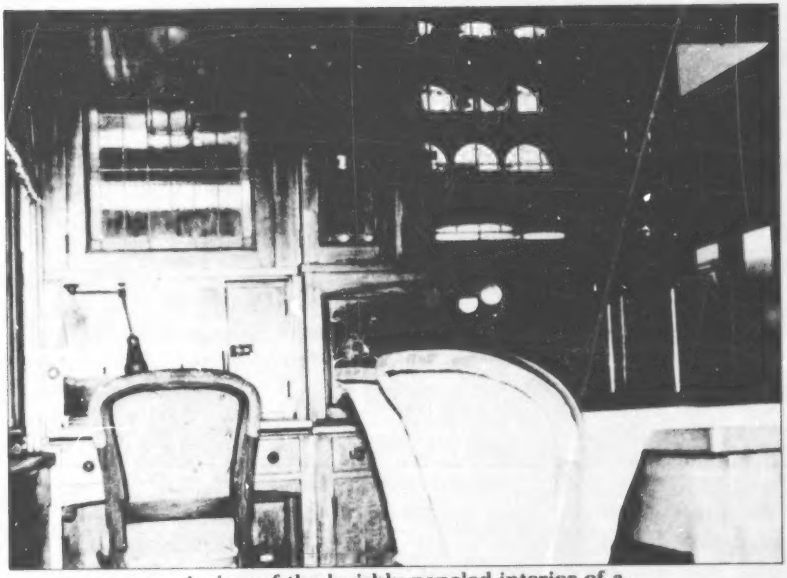
Also displayed is the less splendid, but much more commonplace, Chesapeake and Ohio dining car built in 1925 and not retired until 1960. Recent as this was, the car's layout and appointments—its silverware, custom tableware, real cloth "linens," muted lighting and sheer elbow-room—suggest a kind of grace and comfort that now seem long gone, irretrievably gone, in anything related to public transport in the United States today.

Take a walk through the Missouri Pacific Parlor-Observation car, which for twenty years brought up the rear of the "Missouri River Eagle" passenger train. It had a private dining room, individual reclining seats, air conditioning, and a public address system. Not surprisingly, the latter feature made it unusually attractive to politicians. It was often used by then-Senator Harry S. Truman when he was traveling between Washington and his home in Independence, Missouri.

In addition to illustrating the kind of public transportation that was considered "standard" for Everyman or for soon-to-be Presidents, the St. Louis Museum also bristles with great-idea breakthroughs that unsuccessfully endeavored to help hold their spot as the top-preference public carrier.

Here, for example, you can see the 1800-horsepower B-B Baltimore & Ohio diesel-electric built by General Motors and General Electric in 1935. Originally used to power the B&O's "Royal Blue" Train between Jersey City and Washington, D.C., it was the first high-speed main-line passenger diesel in regular service in the U.S. A mere decade later, it was demoted to local freight service; and then to the indignity of hauling small-time suburban trains.

Another example is the historic Southern 6100, a 1350-horsepower General Motors-made diesel-electric, built as part of the "diesel that did it"—a four-unit demonstrator that was intended to prove the efficiency of diesel power compared to the steam locomotive. And that it did. But this demonstration did little to increase the public's declining willingness to ride passenger trains, and the diesel that did it wound up at the Museum, just like so many of its lesser brethren.



A view of the lavishly paneled interior of a Pullman car on the Delaware and Hudson Line, designed especially for millionaires.

Then there's the impressively named "Silver Charger," an aerodynamic-looking shovel-nosed engine produced for the Chicago-Burlington-Quincy line. If you're an old-car buff it may remind you of some other good ideas that didn't quite make it: the Chrysler *Airflow*, for instance, or the Lincoln *Zephyr*. The Charger first pulled a fast five-hour train between St. Louis and Kansas City, then powered an express-mail train, and was retired in 1965.

Here, also, is the Chicago, Rock Island & Pacific "Aerotrain." Built by General Motors in 1955, it featured lightweight construction, low-center-of-gravity design, and a "futuristic" look intended to bewitch and bedazzle the 400 passengers who could ride in its ten cars. But the Aerotrain had an inferior ride, didn't lend itself to easy switching, and presented special maintenance problems. By 1965, it had nowhere to go but to the Museum.

Other notable examples of obsolescence are the famous Chicago, Rock Island & Pacific caboose that managed to survive 45 years on the Rock Island line and five railroad wrecks, and the 96-foot-long General American GATX, the world's largest tank car. Also shown are the stainless-steel dining car known as the "Silver Spoon", the Panama Canal Locks towing locomotive, one of forty produced by General Electric in 1914 for its specific (and now obsolete) tropical duty, and the refrigerated car built in 1904 for Anheuser-Busch, and said to have hauled some 6.2 million gallons of beer before it was finally retired. For all of which train lovers (and beer drinkers) are endlessly grateful.

THE SAINT LOUIS MEDICAL MUSEUM

3839 LINDELL BOULEVARD, SAINT LOUIS, MO 63108-3470.
Tel: (314) 371-5225.
Hours: Mon–Sat 11 am–4 pm, closed Sun.
Admission: Free.
Publications: Free brochures.
Reproductions: None.
Research: Reference library open to public. The collection is strong in books on quackery and radiology.

The National Collection of Medical Quackery at the St. Louis Medical Museum is a monument to the gullibility of health-hungry Americans. It consists of an array of items confiscated by the U.S. Food and Drug Administration, ranging from the plausible to the downright impossible. As an example of the latter, there's the *Spectro-Chrome*, a cast-iron box with a 1000-watt light bulb, some colored filters, a bottle of water and a $475 price tag. To cure diabetes, you'd take off your clothes, face north during the first quarter of the moon, and turn on the green filter; for heart trouble, you'd use the red light. Then there's the *Violet Ray Generator*, which claimed to cure everything from acne to arthritis. And the $500 Sonus Film-O-Sonic, which played music through electrodes attached to the body; to cure cancer, you'd play "Smoke Gets in Your Eyes."

TERRITORIAL MUSEUM OF HAUTE-BEAUCE

PO BOX 595, LA GUADALOUPE, QUE. GOM lGO. Tel: (418) 459-6255.
Hours: June 1–Sept 15: Mon–Fri 10 am–5 pm; Sept 15–Nov 15: Sun 12–5 pm, and with reservations; Nov 15–May 31: closed.
Admission: $2 adults, $1 senior citizens, children, and students, $5 families. Free to ICOM, AMC, SMQ, and members.
Publications: None.
Reproductions: Posters, prints, postcards of the exhibits, museum and programs.
Research: Research center has extensive popular programs of an experimental nature. They are conceived of and directed by the surrounding community in partnership with the museum.

The Territorial Museum of Haute-Beauce in Quebec represents something new in the way of formal exhibits: an eco-museum in which the "collection" is about everything in the area, including changing folkways and technologies that reflect the cutting edge of the future. The Museum is housed in a former rectory in Saint-Evariste, the geographical center of this rural and largely isolated region. One exhibition currently being developed is about wind, one of the prime factors in the ecological dynamics of the region. Says one observer: "The wind never did stop blowing during the 36 hours I was there. The Beaucerons know about wind."

They also know about everything else in their eco-museum: flora, fauna, buildings, land-use practices, attitudes, tools, etc., as well as weather. That is, in fact, the whole point of the eco-museum concept: its managers are local residents.

APPENDIX 1

MUSEUMS BY REGIONS

NORTHEAST

Academy of Natural Sciences, Philadelphia, PA: *57–60*
American Museum of Natural History, New York, NY: *17–19, 60–62*
American Museum/Hayden Planetarium, New York, NY: *17–19*
Boston Children's Museum, Boston, MA: *145–47*
Buhl Science Center, Pittsburgh, PA: *103*
Carnegie Museum of Natural History, Pittsburgh, PA: *69–71*
The Computer Museum, Marlboro, MA: *149–51*
Con Edison Conservation Center, New York, NY: *152*
Corning Glass Museum, Corning, NY: *152–54*
Franklin Institute, Philadelphia, PA: *25–26, 117–20*
Harvard University Museums, Cambridge, MA: *77–81*
Intrepid Sea-Air-Space Museum, New York, NY: *27–29*
Museum of Broadcasting, New York, NY: *156–58*
Museum of Holography, New York, NY: *158–61*
Museum of Science, Boston, MA: *127–29*
Mutter Museum of the College of Physicians, Philadelphia, PA: *161–62*
Mystic Seaport Museum, Mystic, CT: *162–64*
New York Hall of Science, Flushing, NY: *136–38*
Peabody Museum of Natural History, New Haven, CT: *90–92*
Territorial Museum of Haute Beauce, Haute Beauce, Ontario: *167*

SOUTHEAST

Air Force Space Museum, Patrick AFB, FL: *11–12*
Alabama Space and Rocket Center, Huntsville, AL: *13–17*
Anniston Museum of Natural History, Anniston, AL: *62–63*
Capitol Children's Museum, Washington, DC: *147*
Discovery Place/Charlotte Nature Museum, Charlotte, NC: *143–44*
Fernbank Science Center, Atlanta, GA: *12–13*
Goddard Visitor Center and Museum (NASA), Greenbelt, MD: *26*
Hagley Museum, Wilmington, DE: *120–23*
Kennedy Space Center (NASA), FL: *31–34*
Langley Visitor's Center (NASA), Hampton, VA: *36–37*
Maryland Science Center, Baltimore, MD: *125*
Museum of Science & Industry, Tampa, FL: *133*
Museum of Science & Space Transit Planetarium, Miami, FL: *40–41*
National Air & Space Museum, Washington, DC: *42–45*
National Geographic Society, Explorers' Hall, Washington, DC: *83–84*
National Museum of American History, Washington, DC: *134–36*
National Museum of Natural History, Washington, DC: *84–87*
National Space Technology Laboratories, NSTL Station, MS: *47–48*

Planet Ocean, Miami, FL: *92–94*
Science Museum of Virginia, Richmond, VA: *142*
US Naval Aviation Museum, Pensacola, FL: *53–55*

SOUTHWEST
Arizona-Sonora Desert Museum, Tucson, AZ: *63–65*
Champlin Fighter Museum, Mesa, AZ: *21–23*
Institute of Meteoritics Meteorite Museum, Albuquerque, NM: *26–27*
Lyndon B. Johnson Space Center (NASA), Houston, TX: *29–30*
Kitt Peak National Observatory, Tucson, AZ: *34–36*
Meteor Crater Museum of Astrogeology, Flagstaff, AZ: *39–40*
Mid-America Center, Hot Springs, AR: *125–26*
Museum of Northern Arizona, Flagstaff, AZ: *81–83*
National Radio Astronomy Observatory, Socorro, NM: *45–47*
Roswell Museum, Roswell, NM: *49*
The Science Place, Dallas, TX: *144*
Texas Memorial Museum, Austin, TX: *97–98*
University of Texas, History of Aviation Collection, Dallas, TX: *55–56*

WEST
California Academy of Sciences, San Francisco, CA: *66–68*
California Museum of Science & Industry, Los Angeles, CA: *21, 104–06*
Dinosaur National Monument, Jensen, UT: *73–74*
The Exploratorium, San Francisco, CA: *109–12*
Fleet Space Theater & Science Center, San Diego, CA: *113–14*
Lawrence Hall of Science, Berkeley, CA: *37–38, 123–25*
Lawrence Livermore Laboratories, Livermore, CA: *155*
Mesa Laboratory of the National Center for Atmospheric Research, Boulder, CO: *156*
Oregon Museum of Science & Industry, Portland, OR: *136–38*
Pacific Science Center, Seattle, WA: *138–40*
George C. Page Museum of La Brea Discoveries, Los Angeles, CA: *87–89*
Palomar Observatory, Palomar Mountain, CA: *48–49*
University of Colorado Museum, Boulder, CO: *98–100*

MIDWEST
Neil Armstrong Air & Space Museum, Wapakoneta, OH: *19–21*
James Ford Bell Museum of Natural History, Minneapolis, MN: *65–66*
Center of Science & Industry, Columbus, OH: *106–08*
Cleveland Health Education Museum, Cleveland, OH: *147–49*
Cranbrook Institute of Science, Bloomfield Hills, MI: *71–73*
Des Moines Center of Science & Industry, Des Moines, IA: *108*
Detroit Science Center, Detroit, MI: *108–09*

Fermi National Acceleration Laboratory, Batavia, IL: *155*
Field Museum of Natural History, Chicago, IL: *74–77*
Henry Ford Museum & Greenfield Village, Dearborn, MI: *23–25, 114–17*
Kansas Cosmosphere and Discovery Center, Hutchinson, KS: *30–31*
Lewis Research Center (NASA), Cleveland, OH: *38–39*
Museum of Science & Industry, Chicago, IL: *129–32*
National Collection of Medical Quackery, St. Louis Medical Museum, St. Louis, MO: *167*
National Museum of Transport, St. Louis, MO: *164–66*
Saint Louis Medical Museum, MO: *167*
Science Museum of Minnesota, St. Paul, MN: *94–97, 141–42*
US Air Force Museum, Dayton, OH: *49–52*
University of Kansas Museum of Natural History, Lawrence, KS: *100–01*
University of Nebraska State Museum, Lincoln, NB: *101–02*

APPENDIX 2

MUSEUMS BY SUBJECT CATEGORIES

KEY TO THE CODES

A&S	Air & Space
NH	Natural History
S&T	Science & Technology
ST	Special Topics

Academy of Natural Sciences, Philadelphia, PA **(NH)**: *57–60*
Air Force Space Museum, Patrick AFB, FL **(A&S)**: *11–12*
Alabama Space & Rocket Center, Huntsville, AL **(A&S)**: *13–17*
The American Museum of Natural History, New York, NY **(NH)**: *17–19, 60–62*
American Museum/Hayden Planetarium **(A&S)**: *17–19*
The Anniston Museum of Natural History, Anniston, AL **(NH)**: *62–63*
Arizona–Sonora Desert Museum, Tucson, AZ **(NH)**: *63–65*
Neil Armstrong Air & Space Museum, Wapakoneta, OH **(A&S)**: *19–21*
James Ford Bell Museum of Natural History, Minneapolis, MN **(NH)**: *65–66*
Boston Children's Museum, Boston, MA **(ST)**: *145–47*
Buhl Science Center, Pittsburgh, PA **(S&T)**: *103*
California Academy of Sciences, San Francisco, CA **(NH)**: *66–68*
California Museum of Science & Industry, Los Angeles, CA **(S&T, A&S)**: *21, 104–06*
Capitol Children's Museum, Washington, DC **(ST)**: *147*
Carnegie Museum of Natural History, Pittsburgh, PA **(NH)**: *69–71*

Center of Science & Industry, Columbus, OH **(S&T)**: *106–08*
Champlin Fighter Museum, Mesa, AZ **(A&S)**: *21–23*
Cleveland Health Education Museum, Cleveland, OH **(ST)**: *147–49*
The Computer Museum, Marlboro, MA **(ST)**: *149–51*
Con Edison Conservation Center, New York, NY **(ST)**: *152*
Corning Glass Museum, Corning, NY **(ST)**: *152–54*
Cranbrook Institute of Science, Bloomfield Hills, MI **(NH)**: *71–73*
Des Moines Center of Science & Industry, Des Moines, IA **(S&T)**: *108*
Detroit Science Center, Detroit, MI **(S&T)**: *108–09*
Dinosaur National Monument, Jensen, UT **(NH)**: *73–74*
Discovery Place/Charlotte Nature Museum, Charlotte, NC **(S&T)**: *143–44*
The Exploratorium, San Francisco, CA **(S&T)**: *109–12*
Fermi National Acceleration Laboratory, Batavia, IL **(ST)**: *155*
Fernbank Science Center, Atlanta, GA **(S&T)**: *112–13*
Field Museum of Natural History, Chicago, IL **(NH)**: *74–77*
Fleet Space Theater & Science Center, San Diego, CA **(S&T)**: *113–14*
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Franklin Institute, Philadelphia, PA **(S&T, A&S)**: *25–26, 117–20*
Goddard Visitor Center and Museum (NASA), Greenbelt, MD **(A&S)**: *26*
Hagley Museum, Wilmington, DE **(S&T)**: *120–23*
Harvard University Museums, Cambridge, MA **(NH)**: *77–81*
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Lyndon B. Johnson Space Center (NASA), Houston, TX **(A&S)**: *29–30*
Kansas Cosmosphere and Discovery Center, Hutchinson, KS **(A&S)**: *30–31*
Kennedy Space Center (NASA), FL **(A&S)**: *31–34*
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